POWER

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Unemployment

THE more complex civilization becomes, the greater the implements and forces that it employs, the wider the scope of its constituent activities, the more the need of centralized direction in their function and control.

And one of the first objects of such direction should be the maintenance of an opportunity to earn a living for everybody able and willing to work; the removal of the haunting fear of being out of a job that oppresses everyone whose livelihood depends upon continuous gainful occupation.

The present or early possibility of such an assurance is too much to expect; but with modern facilities for gathering, analyzing, and applying information, it would appear that much could be done to stabilize conditions.

Unemployment is a misfortune not only to its immediate subject but to the community. Loss of employment and purchasing power by some means less demand for the labor of others, and cumulative enforced idleness.

Measures now before Congress call for provision for better employment statistics, an adequate system of public employment bureaus to shorten the period of adjustment from job to job, and intelligent advance planning of public works to permit more and earlier employment when depression threatens private industry.

The needs of the nation are not so inconstant as to warrant wide fluctuations in demand for the staples and for the labor required to produce them.

Ordinary natural variations in crops and the physical returns of labor are not sufficient to produce serious disturbances in the man-power required to keep on going.

Complete and authentic information as to the extent of our normal needs and our producing capacity in installed plant and man-power would seem to be essential to an intelligent, co-ordinated development of our resources and manipulation of our collective facilities.

We have yet to appreciate that universal well-being lies not in an aggregation of competitive units each struggling for its own aggrandizement, but in an organized, regimented, co-ordinated use of our collective resources, means, and abilities:

That we are not a lot of separately functioning interests, but an interlocking and mutually dependent nation.

EDITORIALS

A High-Pressure Paradox

IT IS STRANGE how a slight shift in the point of view can change the aspect of an engineering problem. Take high pressure, for example. It has been stated repeatedly that the industrial plant exhausting to process gains more from an increase in the initial pressure than does the condensing central station.

This is obviously true if one refers to the *percentage* of increase in power obtainable from a given flow of steam or a given weight of coal. In fact, this gain approaches infinity as the back pressure approaches the initial throttle pressure. It is clear, for example, that an increase of initial pressure from 100 to 500 lb., with a back pressure of 50 lb., would increase the power obtainable from a given weight of fuel by several hundred per cent.

One may well say, however, that he is not interested in *percentage* increases but wants to know how much the additional power obtained will cost in coal per kilowatt-hour. This changes the picture entirely. Assuming a constant steam flow, higher pressure requires more fuel and generates more power. The increase in power, divided by the increase in fuel, might be taken as a measure of the thermal advantage. On this basis the condensing plant shows up as well as the back-pressure plant. Both generate the additional power as a "byproduct," with a net heat consumption below 5,000 B.t.u. per kilowatt-hour.

What advantage, then, does increased pressure of throttle steam bring to the back-pressure industrial plant that it does not bring equally to the condensing central station? The answer is found in the special conditions that normally surround the industrial plant, particularly where the load exceeds the present byproduct power capacity. Both central station and industrial plant have the alternative of generating additional power by condensing operation at normal pressures. But this "penalty" for not using high pressures is considerably greater in the case of the industrial plant, because small condensing units consume more fuel than large and have higher fixed charges. If, to avoid this, the industrial purchases the power it cannot generate, it must again pay more than the central station's cost of generating in condensing units.

Thus, valuing the additional power requirements obtained by higher pressure in the industrial plant at the lowest cost for which it could otherwise be obtained, it is clear that the gain is greater than for a central station. This whole discussion is, of course, somewhat academic because space does not permit going into such practically important details as temperature limitations, reheating, water treatment, etc.

Powerton's Economy

ELSEWHERE in this number attention is called to the remarkable sustained record made by Powerton generating station. During December last the heat rate averaged 12,455 B.t.u. per kilowatt-hour of send-out. While possible, such a record was considered almost too good to be true. The accuracy of the records was questioned, so to allay all doubts on this point the meters of the various stations of the system, including Powerton, were calibrated, and the methods of weighing, sampling, and testing coal were checked by impartial experts. In subsequent months the December record was substantiated, as the economy was but a shade lower, for which operating conditions and load might readily account.

Information has been given recently to the effect that for the past six months Powerton has shown an average station efficiency of 12,610 B.t.u. per kilowatt-hour of output, and has generated an average output of 55,341,-

450 kw-hr. per month. The opinion has been expressed that this six months record of the plant has not been equaled by any station.

It must be borne in mind that the foregoing record was made with an initial steam pressure of 600 lb., although all other modern features that would tend to improve the results are incorporated in the design, such as pulverized coal, economizers, air heaters, and tandem-compound turbines, with extraction from four stages to heat the feed water and reheating of inter-turbine steam. With a pressure of 1,200 to 1,400 pounds, some improvement in results might have been obtained; although in any steam cycle starting with an initial pressure above 600 pounds, temperature is a much greater factor than pressure.

The use of a better grade of coal would offer greater possibilities. That used in the plant averages about 15 per cent ash and 12.5 per cent moisture, with sulphur running from 3 to 4 per cent and the heat value approximately 10,000 B.t.u. per pound. It is claimed that Powerton, with a good grade of coal, low in ash and moisture, could produce a kilowatt-hour on 12,000 B.t.u.

Metallurgy in Replacements

MANY YEARS ago Franklin perpetuated in *Poor Richard's Almanac* that well-known quotation: "For want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of a horse the rider was lost . . . etc." The moral of this still holds and finds expression in many ways in the power plant.

Seldom is any part of a mechanism so unimportant that it can be passed over lightly when overhauling equipment or making periodic inspections; for the breakage of a pin, a rod, or a bolt, may result in costly outage and material damage. Too often, when making repairs, there is a tendency to overlook the builders' experience in the selection of materials, even as applied to apparently unimportant parts. Such replacements are sometimes made locally with the idea of saving a few dollars; but there is always the risk that the saving thus effected may eventually be offset many times through failure. Who would think of having a repair part for his automobile made by a local machine shop. Automobiles have been so highly developed that special alloy steels enter into most every part.

Present service demands have made metallurgy all important in power plant work. Few operators are well grounded in the subject, and fewer still have a metallurgist at their call. It is far safer to rely upon the experience of the manufacturer, who has put time, engineering, and money into perfecting the device.

The "nail" is often obscure in power plant work, but one can never tell when its want will be felt.

W.S.E. Active in Civic Affairs

AT THE recent annual meeting of the Western Society of Engineers the retiring president pointed with pride to the civic activities of its members and to the varied public services rendered by the society.

Few engineering bodies have been as active in work of this character, and the example might well be followed by engineering societies or local sections of national societies in other communities. In Chicago it is no longer a question of seeking some way in which a public duty may be performed. Rather the conditions are reversed. Owing to the prestige gained over a period of years, the call comes to the society, and invariably the response is constructive.

So that it may not interfere with the livelihood of its members, work of the society as a body is limited to the establishment of broad policies such as may come up in the administration of the Board of Education, Board of Public Works, or in any department of the city of Chicago, or in the Sanitary District. For example, the management of the Chicago World's Fair recently requested the recommendation of members qualified to advise on safe and economical construction, public safety, power supply and distribution, orderly traffic facilities, etc.

A decision relative to the awarding of a contract, or to any other phase of the work requiring professional service, would not be rendered. Instead a list of qualified engineers would be given, from which selections might be made by the interested department or individual. Policies and projects are the two words that perhaps best distinguish between the work that the society may do and that left to individual members of the engineering fraternity.

It is pleasing to realize that the engineer, the man best qualified to guide public work, is listening to the call of duty, and it is more pleasing to see the growing recognition of the value of engineering services in public affairs. May the good work continue.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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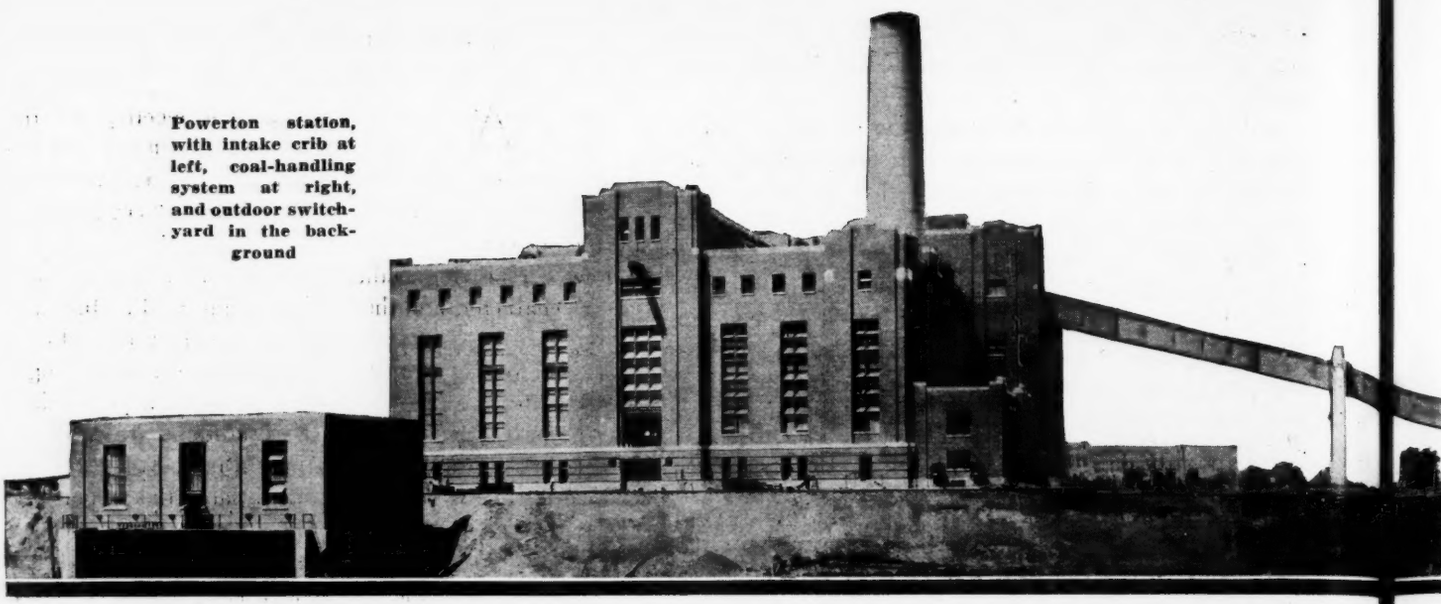


Powerton station, with intake crib at left, coal-handling system at right, and outdoor switch-yard in the background

POWERTON STATION *Shows* EXCELLENT PERFORMANCE

Attains average of 12,455 B.t.u. per kw.-hr. for one month, and 12,546 B.t.u. for four-month period

By **THOMAS WILSON**
Associate Editor of Power

FOR December, 1929, with two 55,000-kw. units in continuous operation, Powerton station of the Super Power Company of Illinois, showed the remarkable average sustained economy indicated by 12,455 B.t.u. per kilowatt-hour sent out. Performance for the next three months closely approximated this, making an average for the four months of 12,546 B.t.u. This excellent performance was obtained from a 600-lb. 725-deg. pulverized-fuel station operating for December on a capacity factor of 72.7 per cent, or an operating load factor of 59 per cent, based upon the maximum output. Considering the fuel, Kincaid coal from Christian County, Illinois, containing 10,045 B.t.u. as received, with ash running in the vicinity of 15 per cent, mine moisture averaging 12.5 per cent, and a sulphur content of 3 to 4 per cent, the foregoing record is outstanding. In terms of the coal specified it reduces to 1.24 lb. per kilowatt-hour.

It will be recalled that Powerton station was projected to wholesale power to four distributing companies: The Commonwealth Edison Company, the Public Service Company of Northern Illinois, the Illinois Power & Light Company, and the Central Illinois Public Service Company. Contractual relations with these four companies call for the entire output, respective deliveries approximating 30, 30, 28, and 12 per cent of the send-out. The first unit went into service Sept. 1, 1928, and the second unit during August of 1929. Work is now in progress for the installation of two additional units, each of 105,000-kw. It is anticipated that the third unit may be ready for service by January, 1931, and the fourth during August of the same year.

For a base load plant of this character, which is not likely to be superseded by any other station for years to come, a location was sought that would insure cheap fuel and a plentiful supply of water. In the Chicago district, to which much of the energy will be transmitted, a suitable supply of condensing water is becoming a serious problem, and coal must be transported 200 miles. These two factors led to the selection of a site on the Illinois River approximately 60 miles from the coal fields and about 10 miles southwest of Peoria. Generation of power near the coal fields and its transmission over high-tension lines to the center of population, versus shipping the coal and generating current at the point of consumption, has been a moot question for years in this territory.

Because of the lack of previous publicity, an outline of the equipment, including the slight differences between successive units, should be of interest. The table of physical data (page 900) gives ratios and capacities for the first unit. This also applies to the second unit.

Each of the two turbine-generators is served by two standard cross-drum boilers and one reheat boiler, with interconnection between units so that the load may be equally divided between the standard boilers that are arranged three on either side of a central firing isle. Each boiler will deliver, at maximum capacity, 275,000 lb. of steam per hour, meaning operation at 500 per cent of rating; while the reheat boiler, with less than one-third that surface, has a steaming capacity of 140,000 lb. per hour. The arrangement of the surface is shown in the sectional elevation of the station. In the standard boiler the tubes are in two banks separated sufficiently to give

These Figures Tell a Story of Record Operation

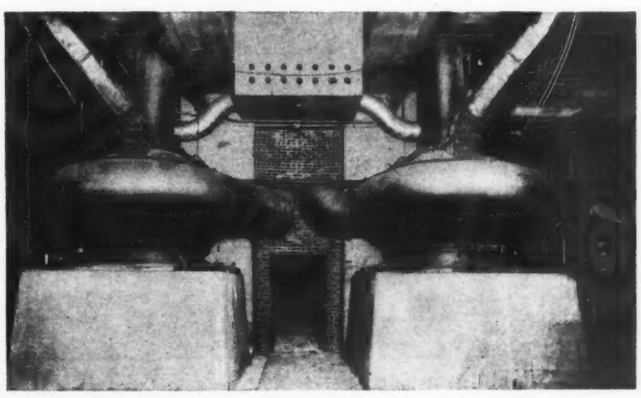
	Dec.	Jan.	Feb.	March
Installed capacity, incl. house generators, kw..	110,000	110,000	110,000	110,000
Absolute maximum capacity, kw.....	128,100	125,100	121,200	118,200
Average daily maximum, kw.....	115,400	113,600	112,200	106,000
Kilowatt-hours sent out.....	56,265,200	60,507,800	54,687,000	56,744,300
Operating load factor, per cent.....	59.0	65.1	67.1	64.5
Capacity factor, per cent.....	72.7	78.4	78.2	73.4
Capacity factor based on 110,000 kw., per cent	68.8	74.0	73.8	69.5
B.t.u. per lb. of coal.....	10,045	10,015	10,161	10,321
B.t.u. per kw.-hr. sent out.....	12,455	12,518	12,548	12,663
Coal per kw.-hr., lb.....	1.24	1.25	1.235	1.227

The geographic location, railroad facilities, and a suitable supply of condensing water settled the issue in this case, and it is probable that a considerable portion of future additions to the generating requirements of the metropolitan area will be solved in like manner. The station has been laid out for an ultimate capacity of approximately 1,000,000 kilowatts.

Factors considered vital in the design were efficiency, continuity of service, and flexibility. Large standard boilers and a special reheat boiler per unit to raise inter-turbine steam to the initial temperature; the use of economizers, air heaters, and tandem-compound turbines, with extraction from four stages to heat the feed water, all contribute to the economy recorded. Pulverized-coal furnaces equipped with unit mills give flexibility. Treated deep-well water passed through evaporators for make-up improves boiler conditions, which, coupled with duplication of auxiliary units, insures reliability of service. This does not mean that stand-by auxiliary units are provided, but that the capacities applying to particular functions are split; therefore, loss of one set of auxiliaries will not cause a complete shutdown, as it is possible to carry about 60 per cent of the load with the duplicate units. An additional advantage comes of the units being smaller than those which would be required for full-capacity operation, so that they may be worked in physically to better advantage in the station layout. The foregoing applies to coal pulverizers, fans, and circulating pumps.

space for a convection superheater. The lower single-pass bank is made up of $3\frac{1}{4}$-in. tubes. In the upper bank, baffled for two passes, are 2-in. tubes.

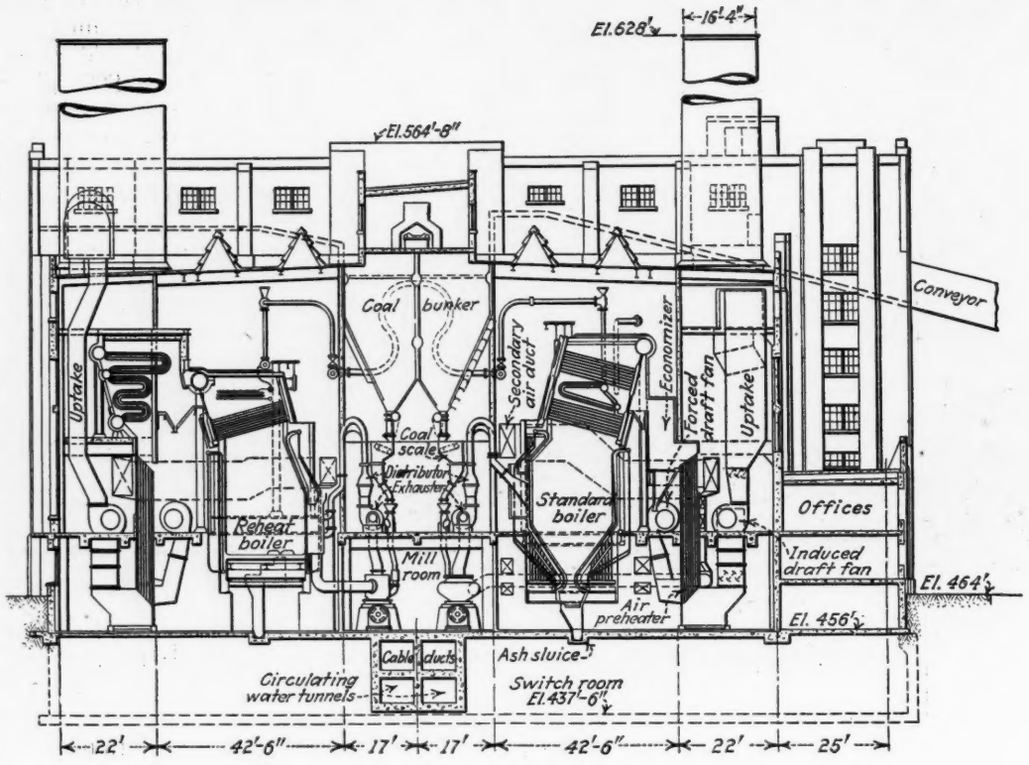
From the boiler the flow of the gases is downward through a return-bend economizer and tubular air heater. At the basement floor level, located at grade, the gases pass into a low-velocity chamber in which the flow reverses, and then pass vertically upward through the induced-draft fans and a long straight duct leading to a lined steel stack of 22 ft. inside diameter serving the unit. This chamber at the low point of gas travel is in an ideal



Ball and pusher mills serving boiler of first unit

position for dust separation. One of the boilers of the second unit is equipped with a dry dust collector at this point. Another boiler of the same unit has a dust collector above the fans. It is probable that in future units similar provisions will be made.

Two induced-draft fans per boiler with a combined capacity of 135,000 cu.ft. per minute provide a static pressure difference of 10 in. Three-speed squirrel-cage motors drive the fans, which are on the operating floor back of the air heaters. Between the boilers and the air heaters, at the same level, are the forced-draft fans, two per boiler. These are also driven by three-speed motors. The air enters the secondary air duct at a temperature of 400 deg. F., leading around the boiler to the burners at the furnace front. For drying the coal, hot air is bled off to the mills through openings in the heater casing. Drying temperature is controlled by regulating the proportion of air from each opening.



Transverse section across boiler house for first two units

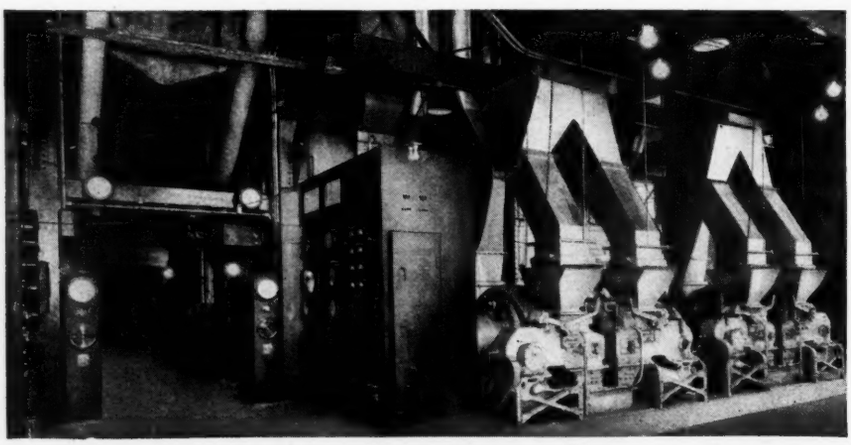
No economizer is used with the reheat boiler; but, because of the large amount of surface in the reheat section, the gases go to the air heater at about the same temperature they possess when leaving the economizer of the standard boiler.

Arrangement of economizer and air heater back of the boiler and placing of fans on the operating floor, make for convenience of operation and for easy access to the auxiliary equipment. With plenty of ground area at reasonable cost, there was no economic reason for placing this equipment over a single-ended boiler.

Control of the boiler auxiliaries is semi-automatic. The operator raises or lowers each boiler as a unit, and the control makes necessary adjustments in coal and air supply by automatic regulation of the feeders, pulverizers, and fans.

With the boilers set high, liberal furnace volumes were provided. At full steaming capacity the heat release approximates 28,000 B.t.u. per cubic foot. Water-cooled surface aggregating 2,900 sq.ft., covered by refractory blocks, protects the furnace walls on all sides, including the hopper bottom ash pits with which the boilers of Unit 1 are equipped. From the pits the ashes drop into a sluicing line and are flushed into an open pit outside the plant. Removal from there is effected by a locomotive crane which transfers the ash into industrial cars. The latter are dumped on the premises to fill low areas. For the time being this locomotive crane also will handle storage coal.

Reference to the sectional elevation will show that pulverizing and fuel-feeding equipment are in the central aisle between the two rows of boilers. The mill feeders and exhausters are on the operating floor, and the mills in a sealed basement room at grade level. Here, too, the dual system obtains. From the bunker to each mill the raw coal passes through an overhead scale and then through either one of two drag-chain feeders, one being a reserve for the other. There are two air-separation ball-and-pusher mills per boiler, one exhauster per mill, and two burners per exhauster, making a total of four burners per furnace, all of the Calumet turbulent-flare type, in which the fuel passes between vertical tubes. The feeders are operated by direct-current motors and the mills and exhausters by slip-ring motors.

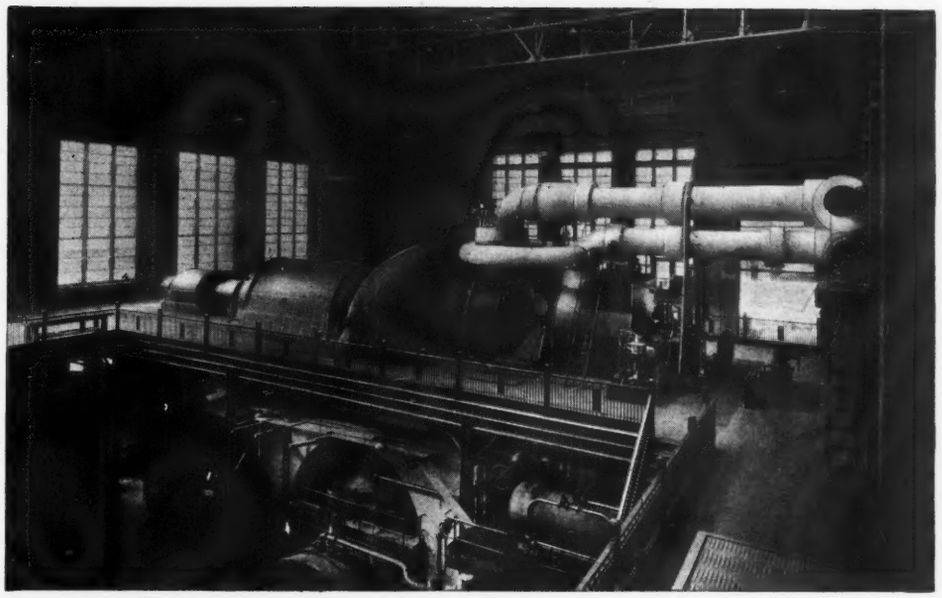


Typical mill feeder installation and control board of unit No. 1. The exhausters are back of the feeders

Following later practice, the boiler

furnaces of Unit 2 are equipped with slag-tap bottoms. Water-cooling surface is limited to the furnace walls, so that the slag remains molten. At intervals the furnace bottom is tapped. In passing down through a spray of water, the molten slag is chilled and shattered, so it may be sluiced away to the pit serving the boilers of Unit 1. With this change the furnace volume is increased to 13,900 cu.ft. compared to 12,900 cu.ft. for the boilers previously installed.

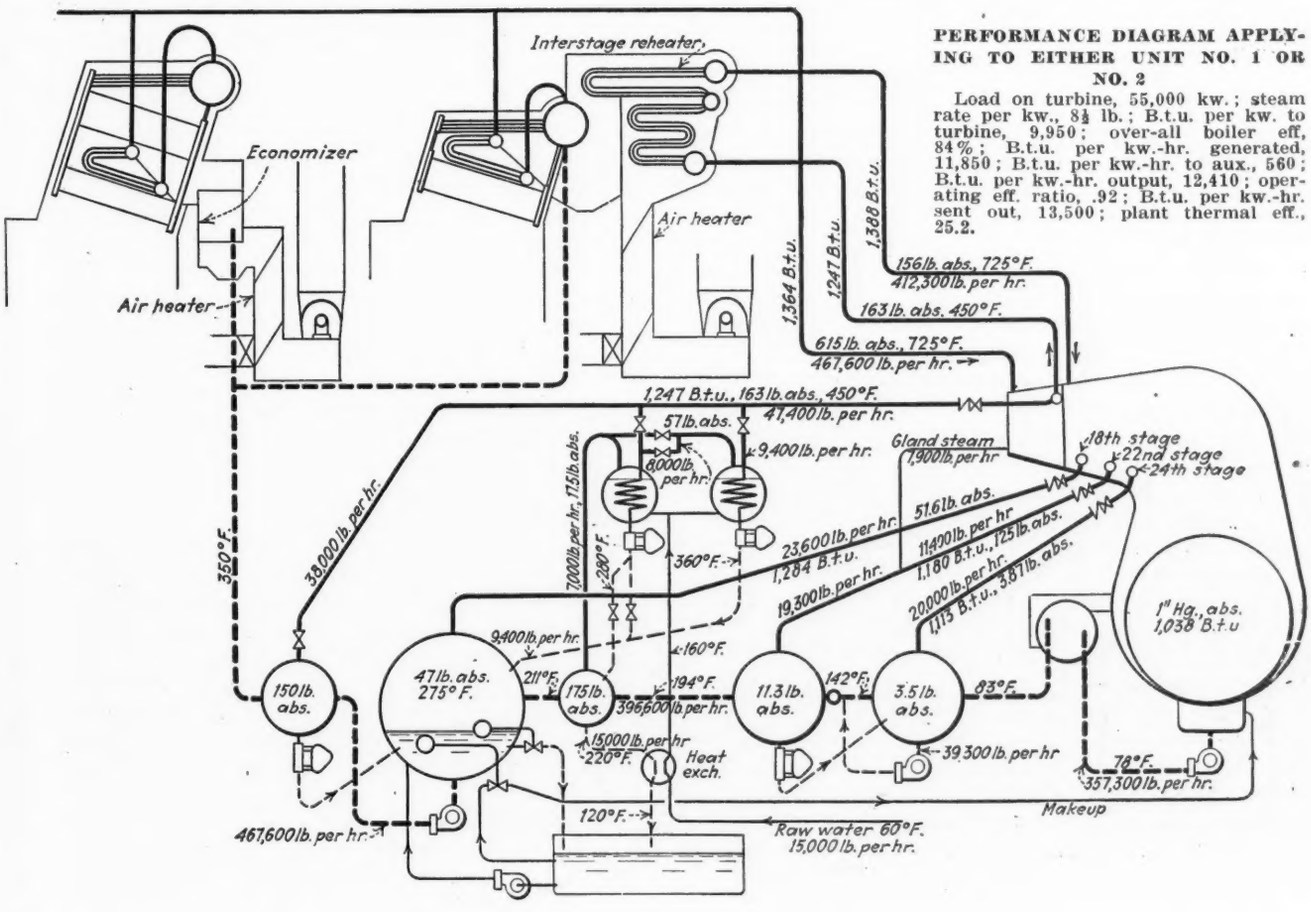
As the mill feeders had proved to be reliable in service, duplicate feeders were eliminated in the second unit. Mills of the same type but of later design were used, and horizontal cross-tube burners were adopted. Otherwise the layout is exactly the same. Experience with the first unit had indicated that two-speed squirrel-cage motors would give the necessary flexibility for fan drives and reduce complication.



Main 55,000-kw. turbine-generator with condenser and air cooler on floor below

The same general design and the splitting of auxiliary capacities will be followed in Units 3 and 4, now in process. The principal difference will be in size. There will be two standard boilers having 30,000 sq.ft. of surface each, and one reheat boiler per unit. Economizers, of the same type, will have 13,000 sq.ft. of surface, and tubular air heaters 55,000 sq.ft. The boiler furnaces will have slag-tap bottoms. Burners will be of the horizontal type, six per furnace, as each boiler will be served by three mills.

Plans for coal handling were made with future expansion in view, as the present system is designed to handle 500 tons per hour. After passing over track scales, the railway coal cars are unloaded by a rotary car dumper. Coal is transferred from the hopper of the car dumper on a belt conveyor to a crusher house equipped with two 350-ton ring-type crushers. An inclined belt conveyor leads to the top of the boiler house, where transfer is



PERFORMANCE DIAGRAM APPLYING TO EITHER UNIT NO. 1 OR NO. 2

Load on turbine, 55,000 kw.; steam rate per kw., 8½ lb.; B.t.u. per kw. to turbine, 9,950; over-all boiler eff, 84%; B.t.u. per kw.-hr. generated, 11,850; B.t.u. per kw.-hr. to aux., 560; B.t.u. per kw.-hr. output, 12,410; operating eff. ratio, .92; B.t.u. per kw.-hr. sent out, 13,500; plant thermal eff., 25.2.

Physical Data on Principal Equipment, Unit No. 1

Consulting engineers	Sargent & Lundy
Building volume, cu.ft. per kw.:	
Boiler room	21.66
Turbine room	15.79
Switch house	0.62
Office	0.86
Machine shop	1.87
Crib house	2.40
Total	43.20

Ratios on installed capacities per kilowatt:

	Total	Per Kw.
Boiler-water heating surf., sq.ft. (exclusive of water walls)	43,820	0.797
Reheat, surface, sq.ft.	20,896	0.380
Steaming capacity, lb. per hr.	590,000	10.727
Furnace volume, cu.ft.	37,500	0.682
Economizer surface, sq.ft.	12,252	0.223
Air heater surface, sq.ft.	84,897	1.543
F. D. fan capacity, cu.ft. per min.	240,000	4.363
I. D. fan capacity, cu.ft. per min.	405,000	7.363
Mill capacity, tons per hr.	55	0.001
Boiler-feed pump capacity, g.p.m.	1,800	0.033
Condenser, sq.ft.	50,000	0.909
Gen. air cooler surface, sq.ft.	3,900	0.071
Circ. pump capacity, g.p.m.	85,000	1.545
Hot-well pump capacity, g.p.m.	2,000	0.036

Standard boilers, two, cross-drum:	
Water heating surface of each, sq.ft.	18,994
Furnace water wall surface, sq.ft.	2,900
Furnace volume, cu.ft.	12,900
Max. steaming capacity, lb. per hr.	275,000
Heat release in furnace at this cap., B.t.u. per cu.ft.	28,000
Operating pressure, lb. gage	650
Steam temperature, sup. outlet, deg. F.	725
Reheat boiler, one, cross-drum:	
Water heating surface, sq.ft.	5,840
Superheating surface, sq.ft.	2,972
Reheating surface, sq.ft.	20,896
Steaming capacity, lb. per hr.	140,000
Reheating capacity, lb. per hr.	475,000
Furnace volume, cu.ft.	11,700
Economizer, counterflow, return-bend, sq.ft.	6,126
Air heaters, tubular:	
On standard boiler, sq.ft.	29,450
On reheat boiler, sq.ft.	25,997
Pulverized fuel mills, ball and pusher, air-separating type:	
Per standard boiler, two, 54-in., 10 tons per hr. each	
Two feeders per mill, drag chain type	
One exhauster per mill	
Four burners per boiler, Calumet type	
Per reheat boiler, two ball mills, air separating, 48-in., 7½ tons per hr.	
Feeders, exhausters and burners same as on standard boiler	
Coal-handling system, capacity in tons per hr.	500
Unloading	Rotary car dumper
Crushers, ring-type, two, tons per hr. each	350
Belt conveyor, width, in.	48
Yard storage	Locomotive crane

Ash-handling, sluicing system to pit, locomotive crane to industrial cars	
Forced-draft fans, two per boiler:	
Capacity of each, 9.5-in. stat. press., c.f.m.	40,000
Speed, r.p.m.	1,200–900–600
Induced-draft fans, two per boiler:	
Capacity of each, 10-in. stat. press., c.f.m.	67,500
Speed, r.p.m.	1,200–900–600
Boiler-feed pumps, three, 4-in., 8-stage:	
Capacity of each, 875 lb. head, g.p.m.	600
Speed, r.p.m.	1,760
Make-up pumps, two, 3-in., volute:	
Capacity of each, 220-ft. hd., g.p.m.	250
Speed, r.p.m.	1,750
Service water pumps, two, 8-in., 2-stage, vertical:	
Capacity of each, 250 ft. hd., g.p.m.	1,700
Speed, r.p.m.	1,150
Deep-well pumps, two, 20-in., 3-stage:	
Capacity of each, 250 ft. hd., g.p.m.	1,000
Speed, r.p.m.	1,170
Heater drain pumps, two, 2-stage:	
Capacity of each, 210 ft. hd., g.p.m.	80
Speed, r.p.m.	1,800
Treated water pumps, two, 140 ft. hd., g.p.m. each	200
Bilge pumps, two, vertical, 35-50 ft. hd., g.p.m. each	500
Air compressors, two, angle compound:	
Capacity, 125 lb. press., c.f.m.	1,130
Speed, r.p.m.	257
Closed heaters, three, 4-pass, floating head:	
Open heater, one, direct-contact, lb. per hr.	420,000
Evaporator, one, two-effect, lb. per hr.	20,000
Water treating system, cold-process, intermittent, lime and soda ash, gal. per hr.	10,000
Turbine-generator, one, total capacity, kw.	55,000
Main generator, 3-phase, 60-cycle, 22,000-volts, kw.	52,500
Aux. generator, 3-phase, 60-cycle, 2,300-volts, kw.	2,500
Surface air cooler, sq.ft.	3,900
Turbine, tandem-compound, 14 high-pressure stages, 12 low-pressure stages; four steam extractions; steam at throttle 600 lb. gage, 725 deg. F.	
Speed of unit, r.p.m.	1,800
Condenser, one, surface, single-pass, sq.ft.	50,000
Circulating-water pumps, two 42-in. vertical, motor drive:	
Capacity of each, 16 ft. head, g.p.m.	42,500
Speed, r.p.m.	225
Hot-well pumps, two, 6-in., 3-stage:	
Capacity of each, g.p.m.	1,000
Speed, r.p.m.	1,170
Air pumps, two, 3 stage, steam-jet:	
Steam, lb. per hr. per element	660
Crane, turbine room, 107 ft. 10 in. span, 40-ft. lift Capacity main hoist, 110 tons; aux. hoist, 20 tons	
Crane, pump room, 10 tons, 24 ft. 6 in. span, 55 ft. 2 in. lift.	
Water screens, traveling, three, 72 in. wide, 48 ft. c. to c.; speed, 9 ft. per min.	

made to a transverse belt with a double-chuted automatic tripper delivering on each side to the overhead bunkers serving the boilers of Units 1 and 2. It will be necessary simply to extend the inclined belt and provide a transverse belt over the respective firing aisles to supply the bunkers for succeeding pairs of units. The main conveyors use 48-in. belts housed in. The various elements of the system are motor driven, with electrical sequence interlocking to insure proper operation.

While the river water at the plant site was considered suitable for condenser cooling, its use for plant service would have involved filtration. As a consequence, preference was given to well water obtained from deep wells sunk on the premises and equipped with motor-driven turbine pumps. The service water is stored in a 100,000-gal. overhead tank, and another tank of the same capacity is provided to store distilled water.

Well water intended for boiler make-up is pretreated in an intermittent cold-process system with lime and soda ash before it is passed to a double-effect evaporator. Most of the time the evaporator is operated single effect. Steam comes from the high-pressure bleeder line at about 150 lb. pressure. Evaporator drips pass to the open heater of the feed-water system, and condensed vapor passes to a hot well. From this point it may be pumped to the open, or direct-contact, heater, or, under float control, admitted to this heater or to the hot well of the condenser.

The accompanying performance diagram, applying to Units 1 and 2, shows the connection of the evaporator to the system, as well as that of the three closed and one direct-contact heater. Passage of the condensate from the condenser hot well may be traced through the inter- and after-condenser of the steam-jet air removal system, through the four heaters and the evaporator condenser, to the economizer or to the drum of the reheat boiler. In its passage the water reaches a final temperature of 350 deg. Three 600-gal. per minute, eight-stage feed pumps serve the three boilers of a unit. Two are motor-driven. A turbine drives the third pump. The water system for the new units will be identical except that a closed heater will replace the open direct-contact heater used in the initial installation.

Each of the two turbine-generators now in operation consists of a tandem-compound turbine driving on the same shaft a 52,500-kw., 22,000-volt main generator (the first machine to be put in operation at this voltage), and a 2,500-kw., 2,300-volt auxiliary house generator. Each generator has a direct-connected exciter. Stand-by auxiliary service is supplied by transformers tapped to the main bus. The high-pressure element of the turbine has fourteen stages and the low-pressure machine twelve stages.

Because of a water rate of 8.5 lb. per kilowatt-hour for the turbine and the four steam extractions, only 0.91 sq.ft. of surface per kilowatt has been provided in a

single-pass, horizontal, divided-waterbox condenser that is connected to the turbine by a water-sealed expansion joint. In accordance with the general plan of design, capacities for condenser auxiliary functions have been divided between two units.

The method of obtaining condenser water is of interest. Owing to the low, marshy ground near the river, the plant was located about half a mile back on gravel soil, where foundations could be constructed more economically, near an abandoned gravel pit. An intake canal joins the river with the pit, and a separate discharge canal returns used water downstream. An intake crib at the edge of the lake formed by the old gravel pit is equipped with the necessary stationary and traveling screens to remove the débris. Also, it houses the condenser circulating pumps, which are of the vertical type with the motors mounted well above high-water level.

Each of the two 105,000-kw. units in the second section of the station will have a three-barrel tandem-compound turbine to drive a single generator with direct-connected exciter. The auxiliary house generator will be omitted from the main shaft for two reasons: first, to reduce the over-all length of the unit, and, second, because it was considered safe to take the station auxiliary power supply from the main bus, for as the station adds capacity the hazard of total outage diminishes.

As at State Line and other late stations, the output switching arrangements are installed outdoors, the power house containing only the generating equipment and auxiliary apparatus. The main 22,000-volt busbars, the oil circuit breakers, and the metal-clad outdoor switch gear are in the outdoor switch yard. Three distinct outdoor substations, all fed from the main bus, step the voltage up to 33,000, 66,000, and 132,000 volts to meet normal transmission line requirements of the four companies purchasing the electrical energy. All auxiliary switching equipment is of the air-insulated metal-clad type, operating at 2,300 volts reduced from the generating voltage of 22,000. The entire 2,300-volt system is interconnected and sectionalized.

Taking Care of Spare Parts in Storage

IN MANY PLANTS that keep renewal parts little attention is given to them until they are needed. It has frequently happened that what was a serviceable part when put in storage becomes useless by the time it is needed.

Electric insulation deteriorates quickly when exposed to moisture and wide ranges of temperatures. Therefore, if spare coils or equipment are stored, attention must be given to them to see that they do not absorb moisture and become defective. Coils should not be stored in a room that is dry and hot or where it is cold and moist. The room should be well ventilated and maintained at a temperature a few degrees above the outside. They should be wrapped in wax paper and packed in a box with excelsior to prevent injury to the insulation and also to provide ventilation. The coils should be carefully labeled, so they may be identified without disturbing the wrapping.

Where completely wound parts are stored, such as armatures, the same rules regarding room temperatures should be followed as applied to the storage of coils. At least once a year they should be tested and if the insulation resistance is found to be low, the windings should be baked and given a good coat of insulating varnish.

▼ ▼ ▼

PROOF THAT TURBINES CAN STAND ABUSE

JUST WHAT may happen to a steam turbine between the time of shipment and delivery is here depicted. The Georgia Power Company, building a 60,000-kw. steam generating plant near Atlanta, Ga., had reached the point in construction where installation of the 60,000-kw. turbine was the final important step. The General Electric Company shipped the turbine, and the engineers made preparations to receive and unload it. But like the missing letter it never came. Investigation revealed that when the car holding the rotor was being hauled over the Seaboard Air Line Railway the front truck jumped the track about nine miles from Tucker, Ga., and after running along the ties for a mile decided to start inland. The rotor was heaved overboard and the blade wheels were buried in the clay.

It speaks volumes for the construction of the modern turbine that after the rotor had been shipped back to the factory and tested none of the blades was found to be loose. Fortunately perhaps, the seventeen-stage wheel was so large in diameter that it had been shipped separately, so these long blades were not called upon to bear the shock of the accident.

COPPER-OXIDE RECTIFIERS Enter the POWER PLANT

A new rectifier, originally developed to charge small storage batteries, is now used to close and open circuit breakers, to supply direct current for operating brakes and control equipment from alternating-current systems, and to supply direct current to other power applications

By I. R. SMITH
Supply Engineer,
Westinghouse Electric & Manufacturing Company

DISCOVERY of the property of copper to copper oxide to rectify alternating current was made by Dr. L. O. Grondahl. As this rectifier has no moving parts, liquids or insulated windings it operates with a minimum of attendance, maintenance, replacement, and operating hazard. The elementary unit of a copper-oxide or Rectox rectifier is a flat copper disk, upon one side of which has been formed a coat of red or cuprous oxide at high temperature. This piece of oxidized metal has the property of passing current freely in the direction of oxide to copper, but which has a high resistance in the reverse direction. Fig. 2 shows the difference in the current passed in the two directions through a single disk at different voltages. At 3 volts, for instance, it passes 9,000 times as much current in the one direction as in the other.

Since the rectifier has a negative temperature coefficient of resistance in both directions, an increase in temperature will tend to lower both resistances. This is of importance only as regards the high-resistance direction through the rectifier. Fig. 3 gives the trend of increase of current through the high resistance at a constant voltage, with increasing temperature. This curve applies only to a specific unit and is not a general curve except as it shows the trend. To prevent too great an increase in back current, means is provided for radiating the heat and keeping the rectifier's temperature within a safe value. Any design has a certain rating for a given ambient temperature.

In building up a unit from individual disks, consideration must be given to making contact with the oxide surface in order to reduce the resistance as far as possble. A common method of doing this is graphitizing. An additional improvement results from the use of a soft-metal contact disk, which is forced into intimate contact with the graphitized surface by pressure. Figs. 4 and 5 show the effects of pressure on units characteristics. Fig. 4 indicates the rate of increase of current in the useful direction with increased pressure at a constant voltage. As might be expected, resistance decreases uniformly with increasing pressure until complete contact is obtained, after which no further change occurs. As the curve shows, this point is reached on a single stack of 1.5 in. diameter disks at about 3,000 lb.. Increase in back current at constant voltage for increasing pressure is seen from Fig. 5 to be negligible until the high value of 6,500 lb. is reached, which is too much for the oxide to withstand.

Since the disks will operate in series or in parallel,

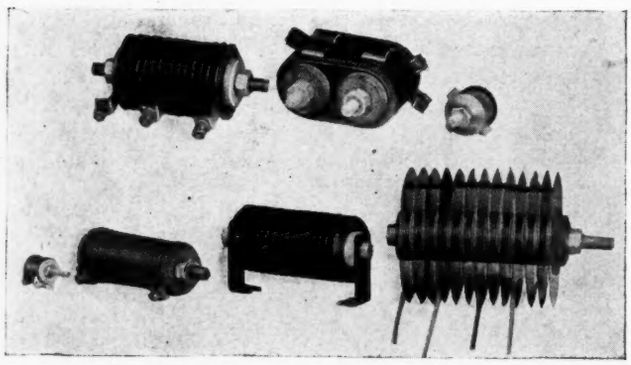


Fig. 1—Different designs of rectifier units

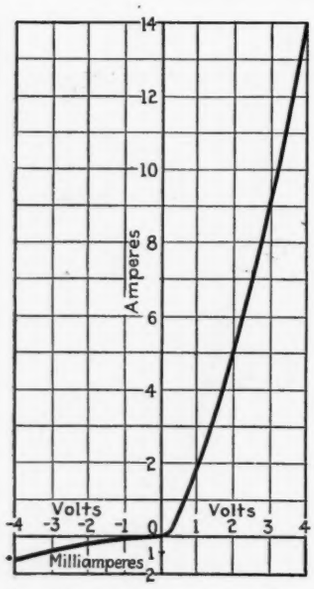


Fig. 2—Volt-ampere curve of 1.5-in. copper-oxide disk

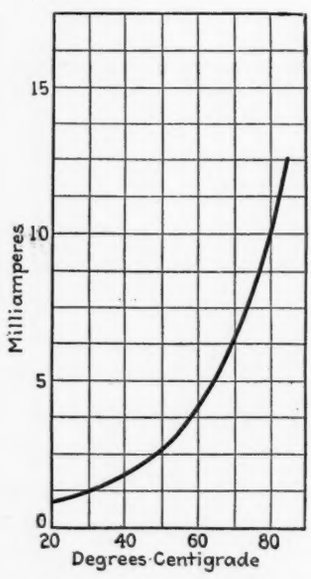


Fig. 3—Temperature-milliampere curve of copper-oxide rectifier

the construction of a complete rectifier for any desired size or rating is simply a problem of assembling the proper number of disks into a unit. Fig. 1 shows a number of rectifier units, identical in principle of construction and differing only in the size of the rectifying disks and in the use of radiating fins. Since no external excitation is required a copper-oxide unit may be built either half or full wave. Full-wave connections may be made either for a bridge-type or center-tapped type of rectifier.

Obtaining maximum efficiency from a copper-oxide rectifier depends upon working the elements at the proper current, voltage, and temperature. Fig. 6 might be termed a fundamental efficiency curve, since it refers to the simplest full-wave bridge-connected unit that could be made, a 4-disk unit having one disk in each leg. Such a rectifier, working at 30 deg. C. and at 0.5 amp. on an 8-volt load, reaches an efficiency of 70 per cent. So long as the current densities, voltage values, and temperature are unchanged, the same curve would fit a unit of any size. Even higher efficiency could be obtained. In practice, however, it usually is not feasible to work at the most efficient point; but an efficiency of 50 per cent is easily obtained.

An outstanding feature of the copper-oxide rectifier is its permanence. While it is true that the resistance

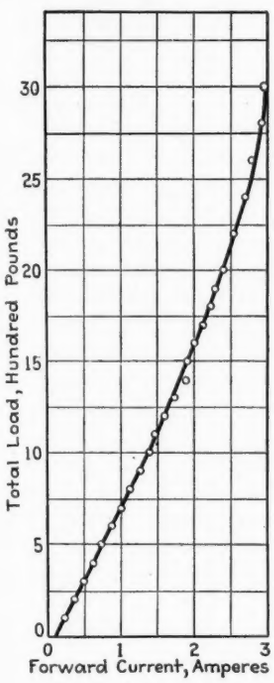


Fig. 4—Rate of forward-current increase with increasing pressure

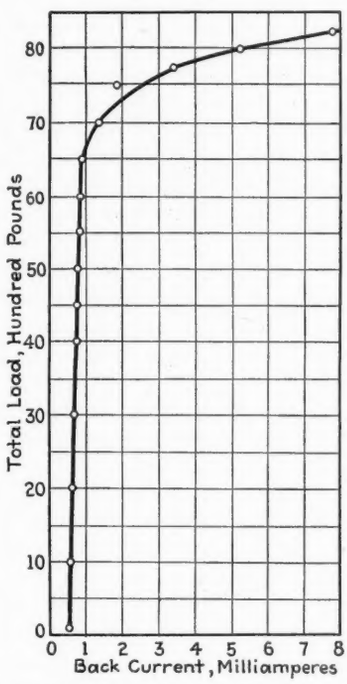


Fig. 5—Rate of reverse-current increase with increase in pressure

of the rectifying element tends to increase with time, the effect of this change can be greatly minimized by proper processing and correct design. Fig. 7 records the progress of a test on a large number of units operating 20 hr. per day for two years, a total of 15,000 hr. At the end of this time the charging current delivered was 80 per cent of the original current. Such a small change in output can be taken care of in various ways if a substantially constant output is desired.

Battery charging is a particularly suitable application for copper-oxide rectifiers, since the flexibility of construction allows of building units for any current capacity from a few microamperes up, and for any voltage. The design shown in Fig. 8 is used on 24-volt batteries such as employed in power plants to trip circuit breakers. This unit delivers charging current variable from 0.1 up to 1 amp. Larger currents or high voltages can be readily taken care of, since the rectifier units can be paralleled or connected in series to any extent desired.

Though suited to battery charging, the copper-oxide rectifier, is not limited to that field. The rectifier may be used without a battery, if continuous reliability of service is not essential, that is if occasional outages resulting from failure of the alternating-current source can be permitted. If desired, not only the voltage but also the wave form of the battery output can be duplicated by the rectifier.

Alternating-current control magnets, relays, and solenoids are often not satisfactory, due to noise, hum, and chattering. As a substitute, direct-current equipment is frequently used on alternating current with a copper-oxide rectifier to supply the direct current. Considerable application has already been made in the field of elevator control and brakes. Similar applications are

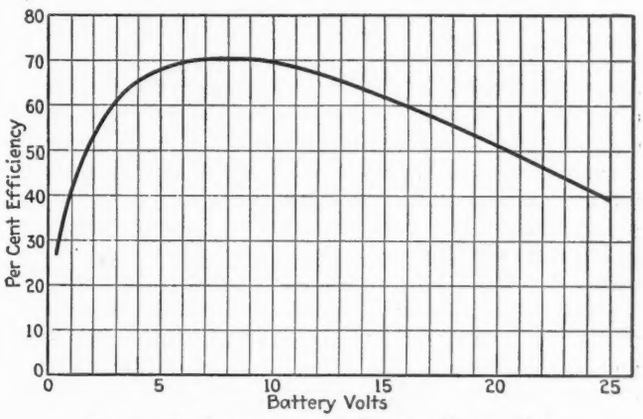


Fig. 6—Efficiency curve of copper-oxide rectifier

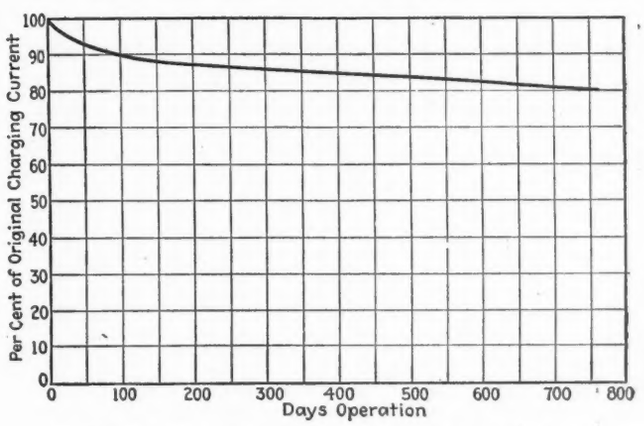


Fig. 7—Life test record of copper-oxide rectifier

being made for other types of apparatus, such as magnetic chucks, clutches, pulleys, solenoid-operated valves, switches, and signals.

Time clocks and bells represent a large class of applications. Here the duty cycle is highly intermittent, involving operation of several each minute, or several times a day. It is possible to take advantage of the rectifier's thermal capacity and overload the units, depending upon the particular cycle of operation. As a result, size and cost of a rectifier can be appreciably reduced.

Operation of circuit breakers, being intermittent, requires large amounts of direct current for short periods,

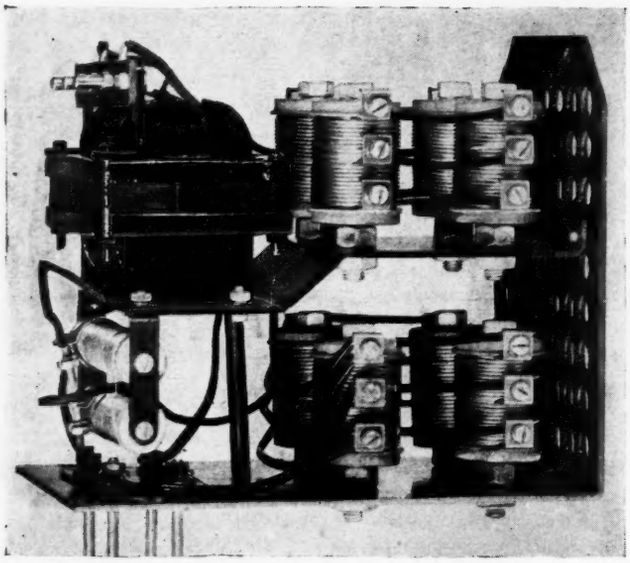


Fig. 8—Rectifier used to charge 24-volt batteries to trip circuit breakers

usually a fraction of a second. Rectifier units are being adopted for closing breakers, operating direct from the alternating-current source. Because of the short period of operation the size, as well as the cost, of the rectifier can be held within reasonable limits. Advantages of such an arrangement from the standpoint of maintenance, especially for unattended substations, are obvious. It is possible to trip breakers, as well as close them, by this means, the only objection being that tripping is dependent upon the availability of the alternating-current supply.

Normal wave form of a copper-oxide rectifier's output is pulsating, varying from zero to maximum. This pulsating current cannot be used for some applications. As an example, supplied direct to a telephone line, pulsating current causes an objectionable hum. In such cases a filter is employed to reduce the ripple in the direct-current to any desired amount.

If desired, a copper-oxide rectifier can be operated direct from an alternating-current line without a transformer. The bridge type of connection is used in this case, unless a half-wave connection is sufficient. The bridge connection can be applied to any number of phases.

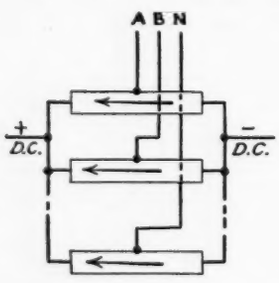


Fig. 9—Diagram of rectifiers connected directly to a three-phase circuit

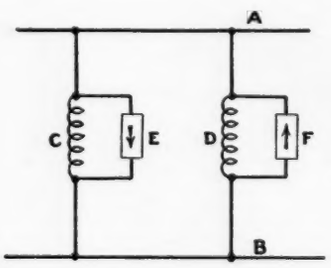


Fig. 10—Rectifiers connected to act as electric valves

The wave shape of the direct-current is improved by a two- or three-phase connection as compared to single-phase. General connections for any number of phases are shown in Fig. 9. Such connections are useful for many types of control problems. For example, a three-phase, 220-volt rectifier will operate 220-volt direct-current control, while a single-phase 220-volt rectifier with a series adjustable resistor can be used for 125-volt requirements.

Another use for the rectifier is found in valve applications. There the Rectox is used not as a rectifier, but as a one-way conductor. For example, where it is desired to admit one-half of an alternating-current wave to a circuit, and to bar the other half, or where it is desired to polarize a circuit so that relays or magnets will operate for one polarity of direct current and not for the other. Here the valve unit can be used, either in series with the relays or in shunt. The number of such applications is large. A simple example is given in Fig. 10, where *A* and *B* represent a direct current of reversible polarity and *C* and *D* are relay coils, while *E* and *F* are Rectox valves arranged to pass current only in the direction shown by the arrows. When *A* is positive, relay *D* will close, *C* being bypassed by valve *E*. Likewise, with *B* positive, *C* will close.

A Show-Boat for Battersea Suggested by London Writer

IMPRESSED by accounts of how the United States Navy's airplane carrier Lexington supplied power to the town of Tacoma, Wash., the London *Electrical Times* sees further commercial possibilities in such a tie-up, and makes this suggestion in regard to London's big Battersea station, now under construction:

"If Dr. S. L. Pearce has not already gone too far with his foundations at Battersea, he might consider the alternative of a floating power house. . . . A power station in separately floatable sections of 100,000 kw. each could easily be designed, and when assembled it could be surmounted by a dance hall with a fine band, cinema, and refreshment pavilion overlooking the river—in other words, a show-boat. Crowds of delighted Londoners would visit this show-boat, to the despair of the Royal Academy, architects, and archbishops, and the profits would bring down the cost of the unit amazingly.

"The cunning of the plot is this: It would take at least two years to get a move on that show-boat every time that an injunction was applied for on the score of sulphurous fumes and corrupt influence. When at length she is compelled to move on by the police, let her shake the mud from her feet and moor elsewhere. The whole flapper vote of a bereaved riverside would be cast against any government guilty of such a crime. With every election she could paddle up river again. It would take twenty years under our dear old British Constitution, to drive the show-boat out to sea. And Liverpool would buy her at almost any price for mooring in the Mersey."

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DURING A RECENT EXAMINATION of old company records, officers of the Lockport Division of the New York State Electric & Gas Corporation were surprised and not a little shocked to discover an item reading "whiskey for meters, $42.50."

Old employees, however, hastened to assure the officers that the whiskey was actually for the meters and not the meter readers. They recalled that the early type of meters used were of the wet type. As whiskey was considerably cheaper and easier to get than it is now, it was used as an anti-freeze solution.

Measuring

Packing Performance

by WORK-FACTOR *Method*

By F. M. McGEARY[1] and C. A. GRIFFITHS[2]

WITHIN the past few years, detail specifications for packing materials to seal joints of machinery against leakage of steam, oil, water, and other liquids and gases have come into more or less common use, largely as a result of the promulgation of a complete set of specifications for this material by the Federal Specifications Board. Of the large users of packing materials, the Navy Department probably has had more experience with specifications for this material than any other single agency; and this experience points to the fact that, while specifications are an absolute necessity when the purchasing must be done in open competition and the lowest priced material conforming to the specifications accepted, some means of evaluating the material offered by the various bidders should be used. The principal reason for this is that a specification is generally a compromise and must of necessity be a statement of the minimum acceptable requirements. Purchasing under specification alone tends to throw the entire volume of business of this character into the hands of those willing to produce material just passing the minimum acceptable requirements, and serves to eliminate from consideration all materials having inherent qualities much in excess of the minimum requirements.

The best raw materials available with poor workmanship, the best workmanship possible to obtain with improper selection of materials, or mediocre workmanship with average materials will each result in a product of relative inferior quality. Chemical analyses of some may show proper proportion of ingredients; physical tests, in some cases, will indicate prospective satisfactory service; yet when installed under actual working conditions, this packing will fail to give good service from one or more of the following causes: shortness of life, leakage, scoring of rods, or high friction.

Notwithstanding the satisfactory results of the chemical and physical tests, the usual means of determining acceptability by specifications alone, packing has failed. It is therefore evident that further tests simulating actual operating conditions and disclosing faults which otherwise would remain undetected until a later date are necessary. When inferior or unsuitable packings are used and this fact disclosed after the machine is in operation, the additional expense of renewing the packing, labor charges, tie-up of machinery, and general overhead are involved.

TABLE I—ASBESTOS HIGH-PRESSURE ROD PACKING WORK-FACTOR METHOD

Analyses of cloth, untreated:	A	B	C	D	E	H	I	M	O
Moisture, per cent	1.21	0.73	0.60	0.60	0.80	0.87	0.96	1.09	0.31
Cotton, per cent	10.63	12.85	6.97	4.14	6.75	12.14	9.51	8.57	7.75
Asbestos, per cent	89.37	86.42	92.43	95.26	92.56	86.99	89.53	90.34	91.94
Analyses of Packing:									
Asbestos cloth, per cent	45.43	41.16	58.97	64.05	51.14	47.62	49.12	50.94	60.57
Rubber back or core, per cent	14.50	4.68	10.05	13.30	14.34	7.60	none	none	13.38
Rubber friction compound, per cent	30.04	48.96	26.17	21.82	29.15	42.04	43.79	36.10	23.39
Lubricant, per cent	10.03	5.20	4.81	0.83	5.37	2.74	7.09	12.96	2.66
Endurance Test:									
Duration of test, hr	2949	1558	1844	2794	2463	1975	2498	1611	2226
Total packing used on test, lb	2.30	3.08	2.42	2.24	2.72	2.18	2.40	3.10	2.20
Work Factor = $bc \div a$, in which	0.00077	0.00197	0.00132	0.00080	0.00110	0.00110	0.00096	0.00192	0.00098

b = Total weight of packing required for endurance test in pounds. c = Arbitrary cost of packing per pound, or $1.00. a = Total endurance of the packing in nours

Chemical and physical tests indicate the ability of the packing to meet certain requirements when based upon previous experience, but in an endeavor to attain the final objective, which is reduction of operating costs, some further means for determining the characteristics of packing under actual operating conditions are essential.

Exact duplication of service conditions in a testing machine is difficult to attain. Further, it is frequently difficult to interpret the results in a testing machine of this sort in such a manner that a readily apparent difference between two products can be applied in the selection of the one which will give the best results for the least cost. The objective in simulative service tests is, obviously, twofold: (1) to weed out unsatisfactory material, (2) to evaluate material which has otherwise met certain minimum requirements. Attainment of the

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[2]Lieutenant, United States Navy.

first is comparatively easy provided the line of demarcation between the acceptable and the unsuitable is accurately drawn and rigidly adhered to. The relative value of different materials is a compromise between cost of the basic ingredients, manufacturing processes, and cost of the finished product. To this end, if there can be adopted and established for each product tested a factor which will identify the characteristics of the particular packing involved, a step toward the solution of the problem of evaluation has been made.

The next step, then, is development of apparatus that will achieve the desired results. A machine which represents, for testing purposes, conditions existing in the stuffing box of a reciprocating engine is shown in Fig. 1. The apparatus consists, essentially, of a 2-in. rod actuated through a 1-ft. stroke by a crank arm at a crosshead on the lower section of the rod. The crank arm is directly connected with a large gear wheel by a shaft, and is run by a 10-hp. motor through a worm drive. Either one or more double-ended stuffing boxes, adequately supported, are the test boxes through which the shaft oscillates. Each stuffing box, fitted with the standard gland, has a depth of $3\frac{3}{4}$ in. and an inside diameter of $3\frac{1}{4}$ in., and takes, therefore, $\frac{5}{8}$-in. packing. The boxes are part of a cylindrical casting 10 in. long that forms a steam

TABLE II—TEST DATA ON FOUR KINDS OF PACKING

	Average Quantity for Test, Lb.	Average Endurance, Hr.	Work Factor		
			Average	Lowest	Highest
Asbestos cloth	2.52	2,213	0.00114	0.00077	0.00197
Semi-metallic	7.32	4,380	.00167	.00127	.00195
Flexible metallic	10.30	2,641	.00390	.00126	.01150
Plastic metallic	3.59	3,708	.00097	.00056	.00137

chest through which the rod operates. An external valve mechanism connected to the crosshead by a rocker arm admits steam, which is exhausted alternately with each stroke of the piston. In this operation the varying pressure acts on the rod in the stuffing boxes in much the same manner as is encountered in actual service conditions. The testing machine is equipped with a revolution counter, a steam pressure gage is fitted in the steam line, and a voltmeter and ammeter is used to determine the power input to the motor.

The vertical position of the rod and its careful alignment prevent wear that would occur with a horizontal rod. The rod is carefully watched for evidence of scoring. A complete overhauling of the box glands and rod is given before the test of each brand of packing.

The following properties of the packing are determined from this test, namely (*a*) the friction, (*b*) the life of the packing, (*c*) abrasive nature of the packing as evidenced by scoring of the rod, (*d*) ability of the packing to effectually seal the rod, (*e*) weight of packing required to effectually seal against leakage during the life of the packing. To obtain this information the following procedure is followed:

1. With the stuffing box empty, the power input to drive the machine is determined.

2. Both stuffing boxes are carefully packed.

3. Either low- or high-pressure saturation or superheated steam, depending on the nature of the service for which intended, is admitted to the steam chest and the gland carefully set up. Leakage will occur as the packing seats itself and adjusts irregularities to the rod.

4. The power input to the machine is again measured.

5. The difference between the input in (*a*) and (*d*) is the power absorbed by the packing in the form of friction.

6. The rod is operated at 75 strokes per minute from 8 a.m. to 4 p.m. daily, starting cold each morning; but it can be operated continuously 24 hr. per day without shutdown.

7. As leakage develops during the test, after the packing has been run in, the gland is set up until leakage ceases. This is done by carefully adjusting the glands to just sufficiently compress the packing and prevent steam leakage with the least amount of friction. When further setting up on the gland fails to stop leakage, additional turns of packing are installed.

8. When leakage can no longer be controlled by the installation of additional turns of packing, the test is completed.

9. Careful record is kept of the hours the packing has been able to effectually seal the rod, the weight of packing used for the test, and the power input. From these data the work-value of the packing is calculated.

The apparatus developed to test rotary rod packings is shown in Fig. 2. It is similar in principle to the testing apparatus devised for reciprocating rod packing, but the 2-in. rotary rod is connected directly to the motor.

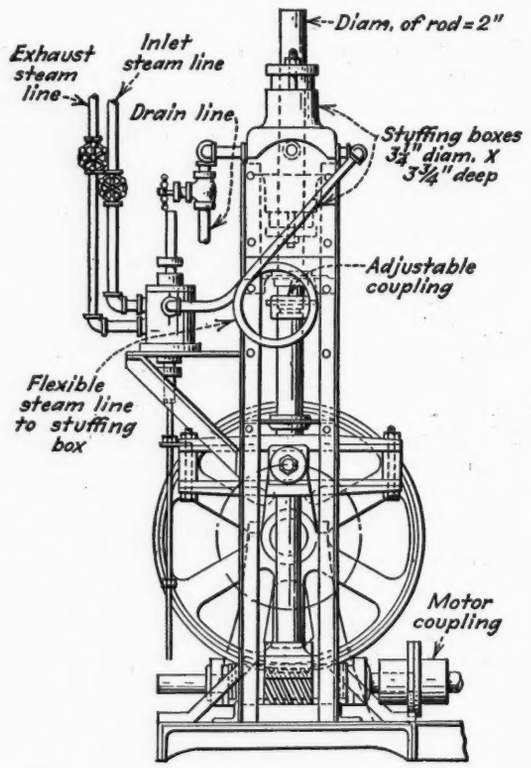


Fig. 1—Testing machine with reciprocating rod

The stuffing box is double-ended, each box being $3\frac{1}{4}$ in. in diameter and $3\frac{3}{4}$ in. long. The rod is rotated at about 3,000 r.p.m. As in the case of the reciprocating testing machine, the packing is carefully installed and adjusted as necessary with additional rings as required during the period of the test. Suitable connections permit the machine to test packing under a vacuum, steam pressure, or fluid pressure. In general, packing is tested for endurance under low- or high-pressure dry, saturated, or superheated steam conditions, and on boiler feed water at 200 deg. temperature and 350 lb. pressure. The procedure followed is similar to that for reciprocating rod packings.

When machines similar to those shown are not available, consistent results can be obtained on any suitable machine in actual service provided all tests are made on the same machine and under identical conditions. When a machine in service is used, care must be taken to see

that the rods and boxes are clean and in good condition, and that the alignment is good. The packing for test should be installed with care and its behavior noted and recorded at regular intervals—several times daily is desirable. To make the information complete and comparable between a number of tests, the following record should be maintained for each brand of packing tested:

1. The manufacturer's name and address.
2. The brand name and style number of the packing, with a complete description which will enable a future comparison of packing offered under the same brand name and style number to be made.
3. Date and hour of installation.
4. Unprejudiced condition of machinery, boxes, and rods.
5. Quantity of packing used to fill box at start of test; number of turns, total weight, and cost per pound.
6. Quantity of packing added during the test; date and hour, number of turns, and total weight.
7. Date and hour of failure of the packing.

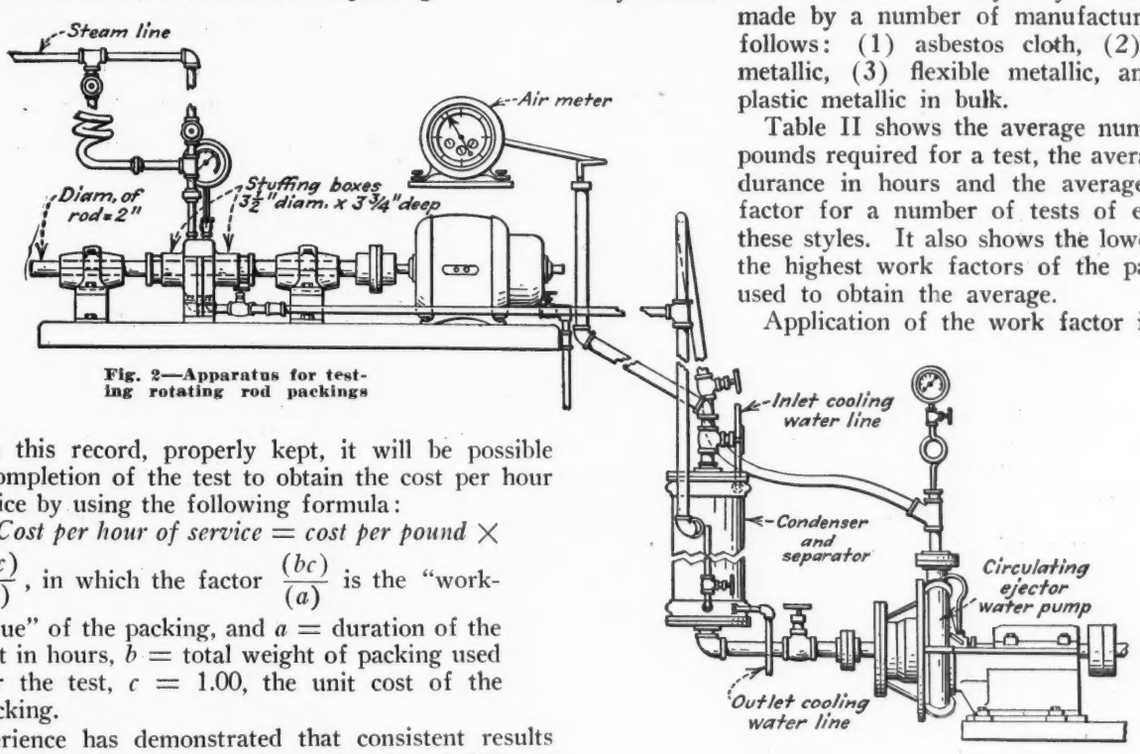

Steam line
Air meter
Diam. of rod = 2"
Stuffing boxes 3 1/2" diam. x 3 3/4" deep
Inlet cooling water line
Condenser and separator
Circulating ejector water pump
Outlet cooling water line

Fig. 2—Apparatus for testing rotating rod packings

With this record, properly kept, it will be possible after completion of the test to obtain the cost per hour of service by using the following formula:

Cost per hour of service = cost per pound $\times \frac{(bc)}{(a)}$, in which the factor $\frac{(bc)}{(a)}$ is the "work-value" of the packing, and a = duration of the test in hours, b = total weight of packing used for the test, c = 1.00, the unit cost of the packing.

Experience has demonstrated that consistent results can be obtained in calculating the work-value of different kinds of packing in the endurance testing machine. Table I gives a summary of the data obtained on nine brands of asbestos high-pressure rod packing, the tests having been made on a reciprocating endurance testing machine similar to that shown. The data include chemical analyses of the packings, analyses of its construction, details resulting from the endurance test, and the work-value calculations.

The analyses of the various packings show that the specifications, as regards construction, have been met in a number of ways and that the poorest and the best packing, from an endurance standpoint, run for 1,558 and 2,949 hr., respectively, or that the best is 89 per cent better than the poorest. It also shows that 2.3 lb. of the best packing will do 89 per cent more service than 3.08 lb. of the poorest packing, or, in another way, it will take 19.75 lb. of the poor packing against 7.82 lb. of the good packing to last 10,000 hr. On this basis and without considering the cost of the additional re-packing necessary with the poor packing, the good packing could cost

TABLE III—COMPARISON OF TEST DATA AND RELATIVE COSTS

	Work Factor	Quantity for 10,000 Hr., Lb.	Estimated Cost per Lb.	Service Cost per 10,000 Hr
Asbestos cloth	0.00114	11.4	$1.25	$14.25
	0.00077	7.7	1.25	9.62
	0.00197	19.7	1.25	24.62
Semi-metallic	0.00167	16.7	2.00	33.40
	0.00127	12.7	2.00	25.20
	0.00195	19.5	2.00	39.00
Flexible metallic	0.00390	39.0	1.00	39.00
	0.00126	12.6	1.00	12.60
	0.01150	115.0	1.00	115.00
Plastic metallic	0.00097	9.7	1.50	14.55
	0.00056	5.6	1.50	8.40
	0.00137	13.7	1.50	20.55

2½ times as much as the poor packing and still be as cheap.

Every consumer of packing should develop a work-factor method such as this, so designed as to meet his own needs based on actual operating conditions. He will then be able to judge between several brands of the same style of packing or between several styles of packing suitable for the same service. High-pressure rod packing may be obtained in at least four major styles commonly made by a number of manufacturers, as follows: (1) asbestos cloth, (2) semi-metallic, (3) flexible metallic, and (4) plastic metallic in bulk.

Table II shows the average number of pounds required for a test, the average endurance in hours and the average work factor for a number of tests of each of these styles. It also shows the lowest and the highest work factors of the packings used to obtain the average.

Application of the work factor in ultimate selection of a particular style of packing naturally involves the cost of the packing. Combining work values illustrated in Table II with roughly estimated costs per pound of the packing, a comparison is shown in Table III. In this table it has been assumed that the test period is 10,000 hr. for each packing. Column 5 of Table III, then, shows the cost of four different kinds of packing for this period of operation.

The chief operating engineer of a plant can well afford to conduct his own research, for by so doing not only his knowledge of packing problems is enhanced, but he will become more experienced in judging the relative merits of both different brands of packing and different styles of packing for a given service. As it is realized that the total packing costs of a plant are merely the summation of the costs of the small individual installations, the grand total may assume an imposing figure. Careful selection, correct application, and proper installation will reduce operating costs, maintenance costs, and tie-up of machinery.

PROTECTING BOILERS FROM EMBRITTLEMENT

By J. J. BRENNAN
Testing Engineer
Northern States Power Company

Use of a modified alkalinity ratio including sodium carbonate as well as sodium sulphate in the numerator is suggested. A study of the deposits formed when sodium salts crystallize from solution also is desirable, as they may form films that will protect metal from attack by caustic soda and thus act as inhibitants of embrittlement

SEVERAL YEARS AGO the writer was called upon to investigate the cause of cracking of metal in the drums of a number of steam boilers which had been in service for approximately four years. It was concluded that the cracking of the metal was due to a number of factors, one of them being the character of the boiler-feed water, which did not comply with the A.S.M.E. recommendation[1] relative to the maintenance of certain ratios of sodium sulphate to the soda (methyl orange) alkalinity, as follows:

Working Pressure of Boiler, Lb. Gage	Ratio of Sodium Sulphate to Sodium Carbonate Alkalinity
0 to 150	1
150 to 250	2
250 and over	3

In view of the cracking of these boilers when using feed water having a low ratio of sodium sulphate to sodium carbonate alkalinity, it was decided to make a survey of the water conditions existing in a number of steam stations operated under the same management in various sections of the United States. The results of this survey showed that in only nine of twenty stations did the boiler water comply with the A.S.M.E. recommendations. It appeared that eleven plants were in danger of developing boiler metal cracking if they were not already so afflicted. Removal of the rivets and examination of the metal in a number of these boilers failed to show any cracking of the metal. Yet a number of boilers in these plants had been operating since 1910 using water softened by various methods, including zeolite softening and boiler compounds containing soda ash and in some cases caustic soda.

TABLE I—ALKALINITY RATIOS IN BOILER WATERS OF PLANTS IN SURVEY

Station	A	B	C	D	E	F	G	H	I	J	K
Steam Press. Lb. Gage	235	185	160	235	250	160	200	250	185	160	240
Ratio: $\frac{Na_2SO_4}{\text{Tot. Alkalinity}}$	0.71	1.88	0.85	1.59	1.13	1.64	0.49	1.33	0.38	0.30	1.09
Ratio: $\frac{Na_2SO_4+Na_2CO_3}{NaOH}$	3.01	3.29	...	3.26	2.75	5.00	5.89	3.34	19.43	4.55	1.75

It seemed unnecessary to resort to special water treatment in these plants to maintain the ratio recommended as desirable for the prevention of metal cracking. Besides it would have been difficult to obtain executive approval of the capital expenditure and increased operating cost that such special treatment would have entailed. Consequently, further study of water conditions in these plants and the general subject of boiler metal cracking, often referred to as "caustic embrittlement," was undertaken.

Parr and Straub, in Bulletin No. 155 of the University of Illinois engineering experiment station, reported the results of laboratory tests showing the effect of Na_2CO_3 as an inhibitant of embrittlement, stating that on account of the similarity of sodium sulphate and sodium carbonate as to solubility in sodium hydroxide inhibitive power might be attributed to undecomposed sodium carbonate, as well as to sodium sulphate.

It was then considered, in relation to the plants previously mentioned, that sodium carbonate, as well as sodium sulphate, should be in the numerator of any ratio established as indicative of the tendency of a water to cause embrittlement. Furthermore, caustic soda was considered as the dangerous chemical, and a modified ratio $\frac{Na_2SO_4 + Na_2CO_3}{NaOH}$ was determined upon to apply to the boiler waters in these plants. It was found, as shown in Table I, that the boiler waters from all of the plants, except Station K, considered subject to embrittlement when judged by the ratio of $\frac{Na_2SO_4}{\text{Total Alkalinity}}$, carried ratios of $\frac{Na_2SO_4 + Na_2CO_3}{NaOH}$ in excess of 2.

The drums in all boilers in Station K developed the metal cracking that led to the survey of water conditions in other stations. It will be noticed that the boiler water in this station carried a ratio of $\frac{Na_2SO_4}{\text{Total Alkalinity}}$ considerably higher than a number of other stations, but the ratio of $\frac{Na_2SO_4 + Na_2CO_3}{NaOH}$ was less than 2.

[1]See Appendix to "Suggested Rules for the Care of Boilers," published by A.S.M.E. Boiler Code Committee in 1926.

Analyses of waters from embrittled boilers given in Bulletin No. 177, engineering experiment station of the University of Illinois, p. 26, show ratios lower than those recommended by the A.S.M.E. and also that the ratio

$$\frac{Na_2SO_4 + Na_2CO_3}{NaOH}$$

in all cases to be less than 2, as shown in Table II.

These facts tended to confirm the decision that it was not necessary to maintain the A.S.M.E. ratio in boiler waters and that embrittlement or cracking of metal need not be feared in boilers provided the ratio

$$\frac{Na_2SO_4 + Na_2CO_3}{NaOH}$$

was maintained in excess of 2.

Many theories have been advanced to explain the inhibiting action of sodium sulphate and sodium carbonate, such as dilution, change of electrolytic potential, and the mechanical protection by deposits formed through lowering of the solubility of the salts by caustic soda. Perhaps the most reasonable explanation of the inhibiting action lies in the effect of sodium compounds upon the solubility of other sodium compounds and the nature of the deposit formed when the least soluble sodium salt is precipitated upon concentration of the boiler water in the small spaces between straps and plates of riveted joints.

If solubility alone determines the value of an inhibitant, it would be expected that other sodium salts, such as sodium chloride and sodium nitrate, would show inhibiting action, because their solubilities are depressed by the presence of caustic soda in a solution. Yet Parr and Straub, in Bulletin No. 177 of the engineering experiment station, University of Illinois, p. 40, have reported that laboratory tests indicate that the presence of sodium chloride in a caustic soda solution accelerates embrittlement.

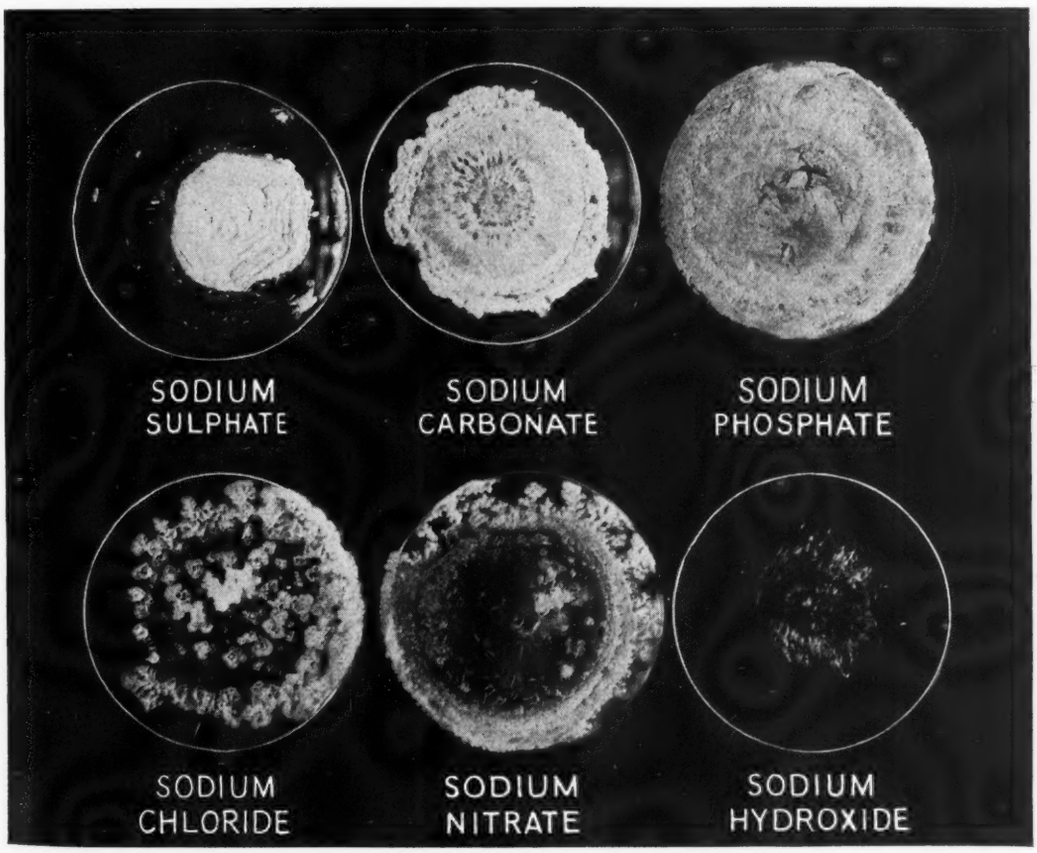
It occurred to the writer that the forms in which various sodium salts crystallize from solution might have a bearing on the value of these salts in forming films that would protect metal from attack by caustic soda, and thus act as inhibitants of embrittlement. Six sodium compounds were therefore crystallized from solution and the crystalline deposits formed were photographed as shown in the accompanying illustration (originally published in *Byllesby Management*, May 1928).

It will be seen that sodium sulphate, sodium carbonate, and sodium phosphate, when crystallized from solution, form dense, fine-grained, and practically impervious coatings. Whereas, sodium chloride, sodium nitrate, and sodium hydroxide, when crystallized from solution, form deposits which are not sufficiently impervious to form a film that would prevent caustic soda from coming in contact with the boiler metal.

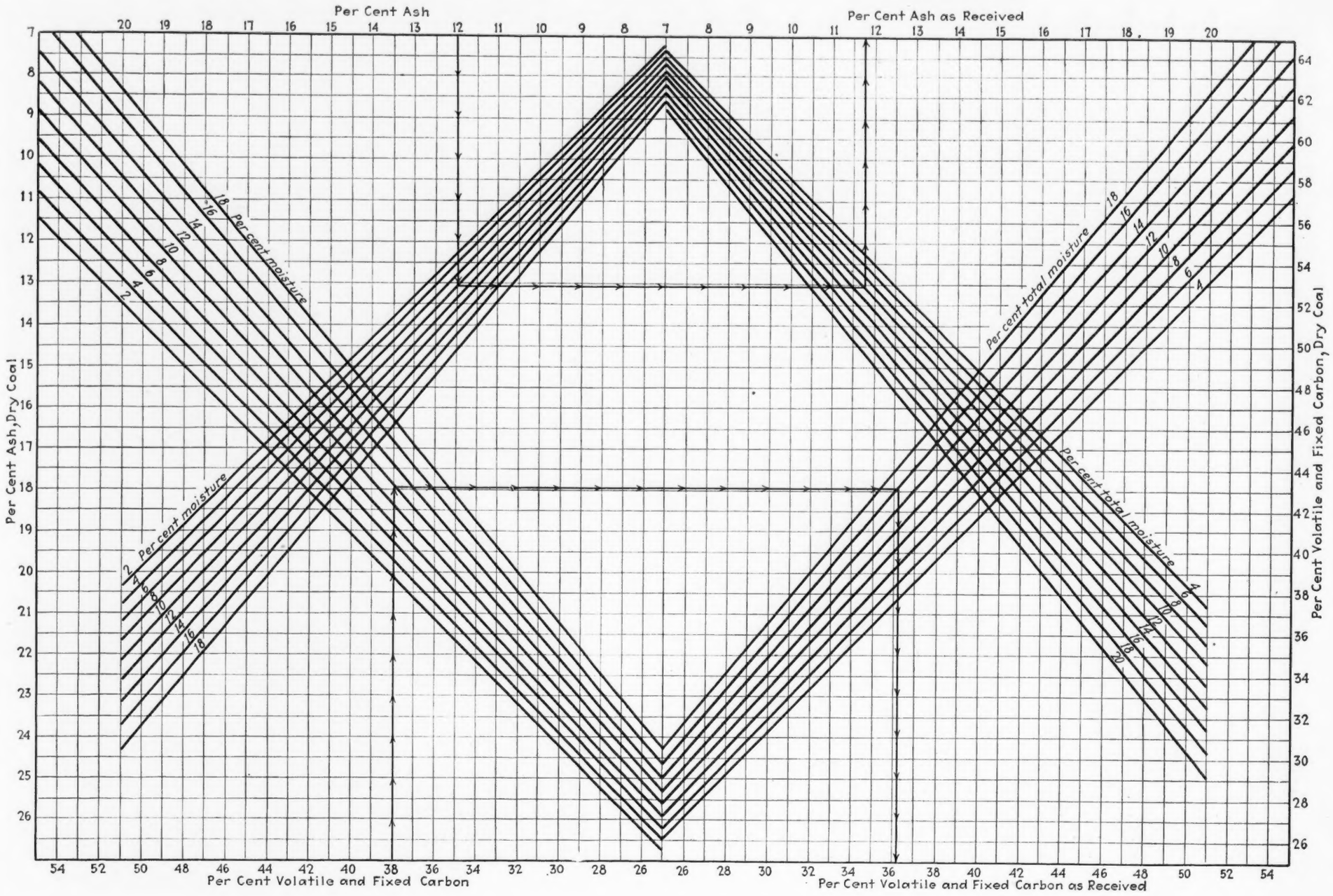
TABLE II—RATIOS IN WATERS FROM EMBRITTLED BOILERS

Steam Pressure Lb. Gage.....	200	250	200	30	225	265	60
Ratio: $\frac{Na_2SO_4}{\text{Total Alkalinity}}$	0.24	0.81	0.15	0.21	0.15	0.50	0.04
Ratio: $\frac{Na_2SO_4 + Na_2CO_3}{NaOH}$	1.33	1.92	0.61	1.52	0.41	1.09	0.31

Very little is known in regard to the solubility characteristics of sodium salts at high pressures and temperatures, but it is thought that investigations which no doubt will be undertaken to determine the solubilities of these salts under boiler operating conditions should give some attention to the character of the deposits formed when the sodium salts crystallize from solution.



Crystalline deposits from six sodium compounds


Per Cent Ash
Per Cent Ash as Received
Per Cent Ash, Dry Coal
Per Cent Volatile and Fixed Carbon, Dry Coal
Per Cent Volatile and Fixed Carbon
Per Cent Volatile and Fixed Carbon as Received
Per cent moisture
Per cent total moisture

Simplifying Ash, Volatile and Fixed Carbon Determinations

By M. L. Burden
Engineer of Tests, Western Electric Co.

THE chart on the opposite page was constructed to save time in making the various calculations necessary to put the ash, volatile, and fixed carbon in coal on a "dry" and "as-received" basis. In plants where proximate analysis of coal are made on each car, considerable time is taken up in making the various calculations from the analyses of the coal. With this chart use of the formulas may be eliminated and results obtained from the curves that will meet all practical purposes.

To use the curves, assume 12 per cent moisture after air drying, total moisture of 16 per cent, and 38 per cent volatile or fixed carbon, as determined by analysis after air drying. It is desirable to report on a dry or moisture-free basis; also on an "as-received" basis. Follow the procedure indicated by the arrows, which show the volatile and fixed carbon in the dry coal at 43.1 per cent; and, with 16 per cent total moisture, 36.2 per cent as received.

The procedure shown at the top of the chart applies for the ash. Assume the coal shows a total moisture of 10 per cent, an ash content of 12 per cent, and moisture of 8 per cent as received in the laboratory. Following the arrows will give practically 13.1 per cent ash on the dry basis, and 11.8 as received.

Use of the curves eliminates the formulas given below.

Calculations from analysis of "air dried" coal to coal "as received."

$$\textit{Volatile matter} \times \frac{100 - \textit{Air drying loss}}{100} = \textit{Volatile matter as received}$$

$$\textit{Fixed carbon} \times \frac{100 - \textit{Air drying loss}}{100} = \textit{Fixed carbon as received}$$

$$\textit{Ash} \times \frac{100 - \textit{Air drying loss}}{100} = \textit{Ash as received}$$

Calculations from "air dry" or "as-received" analysis to "dry coal."

$$\textit{Volatile matter} \times \frac{100}{100 - \textit{Moisture}} = \textit{Volatile matter in dry coal}$$

$$\textit{Fixed carbon} \times \frac{100}{100 - \textit{Moisture}} = \textit{Fixed carbon in dry coal}$$

$$\textit{Ash} \times \frac{100}{100 - \textit{Moisture}} = \textit{Ash in dry coal}$$

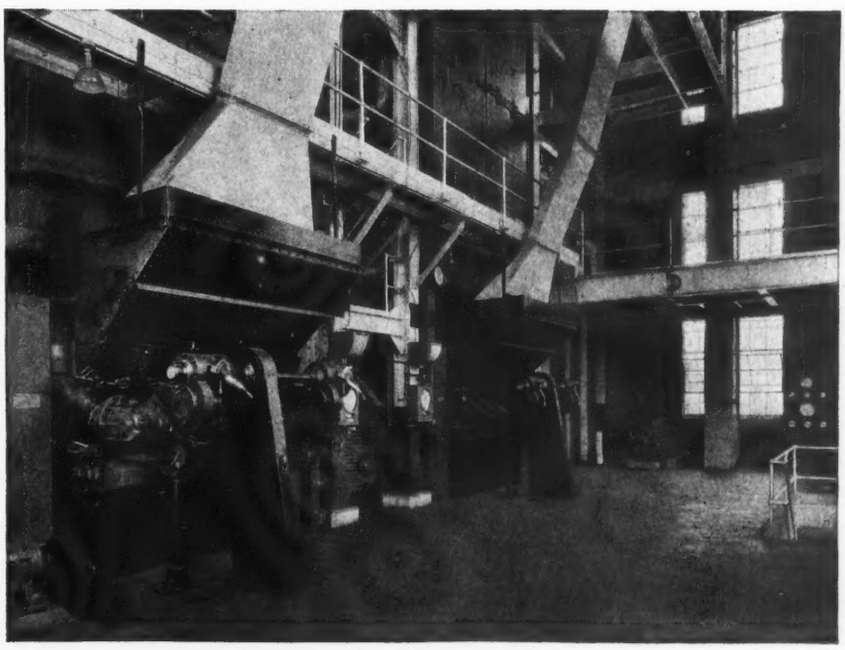
▼ ▼ ▼

Textile Mill's New Plant Provides for Future Generation

THE Slatersville Finishing Company, a division of the Kendall Company at Slatersville, R. I., recently put into operation its new boiler plant. Equipped with two 12,000-sq.ft. units, with provision for a third, the plant furnishes process steam for the many requirements of a textile finishing plant, and the equipment is adaptable to steam power generation when that becomes advisable. Present consumption of steam for processing is at the rate of 150,000,000 lb. a year.

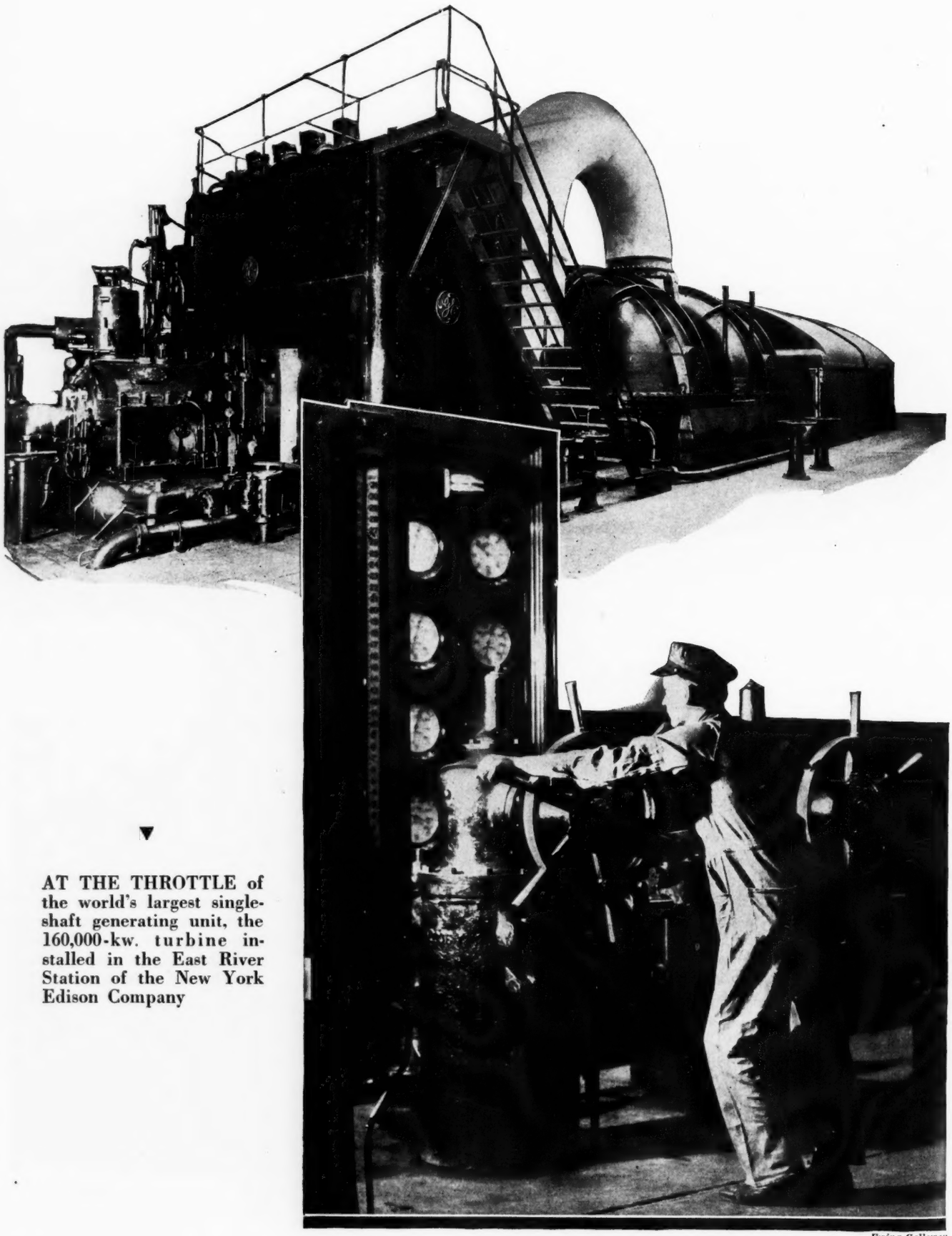
Measuring 82 ft. long x 53 ft. wide, 53 ft. high over the boiler space and 75 ft. high over the coal bunker space, the building is a self-supporting steel frame structure with brick walls on three sides and tile wall at one end, providing for future addition. The coal bunker is suspended overhead, and has a capacity of 200 tons. From the bunker coal is passed through an automatic coal scale, one for each boiler, with 200 lb. capacity per dump or six tons per hour to the stoker hopper.

The two B. & W. cross-drum boilers, equipped with superheaters and soot blowers, operate at 150 lb. gage, with 50 deg. F. superheat; but they are designed to operate at 250 lb. with 150 deg. superheat when steam power generation becomes a part of the plant's service. Front headers are 16 ft. above the operating floor, and the boilers are fired by fire-retort stokers having a projected grate area of 123.7 sq.ft. each, capable of driving the boilers at 300 per cent rating. Stokers are driven either by a four-speed motor or by steam turbine. Furnaces are 9 x 14 ft., with air-cooled walls at front and sides and a water-cooled rear wall. Ash hoppers with quenchers and water-sealed sliding gates are installed under each boiler. All controls are so located that they may be developed to "full automatic" as plant load increases. Charles T. Main, Inc., engineers, of Boston, Mass., designed the plant.



Front of the boilers, showing the automatic cool-scaling equipment

CONTROLLING 160,000 KW.



Ewing Galloway

AT THE THROTTLE of the world's largest single-shaft generating unit, the 160,000-kw. turbine installed in the East River Station of the New York Edison Company

. . . RIGHT OUT OF THE PLANT . . .

Practical Substitute for Pump Valve Spring

SEVERAL light conical coiled springs over the flat rubber water valves were found broken on a pump which was working where new ones could not be procured for some time. Several old automobile seat springs

Spring formed and in position on pump valve

were readily procured, however. They were cut off at a free length, giving about the same compression when under the guide stud as the regular brass spring. The small end was bent in to fit around it under the stud shoulder. They made an excellent substitute, working nicely until new ones arrived. F. W. BENTLEY, JR.

Missouri Valley, Iowa.

Five- and Six-Day Week Schedules for Power-Plant Operators

IT IS well within my memory when power house employees worked eleven hours a day and thirteen hours a night, with a twenty-four-hour tour of duty every two weeks in order to change shifts. It is hard to realize how anyone could work eleven hours daily for thirteen days, twenty-four hours on the fourteenth day, and then thirteen hours for thirteen days before he had a day off. Anyone who works twenty-seven days such long hours cannot add much to the advancement of either his own welfare or that of the community.

But most of us are convinced that the foregoing system is passé. The next step toward shorter hours was the eight-hour shift, three shifts a day (8 a.m. to 4 p.m., 4 p.m. to midnight, and midnight to 8 a.m.) seven days a week with straight time for Sundays. The change of shifts was accomplished by either a sixteen-hour tour of duty every week or by the short-shift method, where the second-shift man on Saturday worked the first shift on Sunday, the third-shift man worked the second shift, and the first-shift man worked the third shift. Although the eight-hour shift seven days a week was a big improvement from the eleven- to thirteen-hour shifts, it did not give the men sufficient time off for recreation and self-improvement. The sixteen-hour swing gave each man a Sunday off once in three weeks, but the sixteen-hour tour of duty was objectionable. The short-shift method of change was also objectionable for those who lived a distance from the plant, since they had to return to work within eight hours.

The next step toward shorter hours was the six-day week. This plan provides for one extra man for each six men employed. Where six men work at the same job it is not difficult to work out a schedule, but where three men work on one job and three on another it is not so easy. The following schedules have been worked up to show possible combinations:

SCHEDULE NO. 1

Shifts	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
First Week							
1	A D	X D	X D	X D	C X	C X	C X
2	B E	B E	A E	A E	A E	A D	A D
3	C F	C F	C F	B F	B F	B F	B F
Second Week							
1	C F	C(X)F	X F	X F	X F	B X	B X
2	A D	A D	A D	C D	C D	C D	C F
3	B E	B E	B E	B E	A E	A E	A E
Third Week							
1	B X	B E	B(X)E	X E	X E	X E	A X
2	C F	C F	C F	C F	B F	B F	B F
3	A D	A D	A D	A D	A D	C D	C D

Schedule 1 gives every man six days a week. The shift men have one Sunday off in eight, and the relief men two Sundays off in eight. The main objection to this schedule is that it is necessary to work the relief man on some other job one day a week six weeks out of eight. Another objection is that each man works eight days straight before he has a day off even though he works but six days in any one calendar week.

SCHEDULE NO. 2

Shifts	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
First Week							
1	A D	X D	X D	X D	C X	C X	C X
2	B E	B E	A E	A E	A E	A D	A D
3	C F	C F	B F	B F	B F	B F	B E

This schedule is the simplest. The relief man works steady days and no Sundays. The main objections to it are that each man has a choice of only three different

days off a week, works every Sunday, works the day shift only four days in three weeks, and must work seven straight days without a day off. This schedule can be used where A B C and D E F work at different jobs and receive different rates. It is probably the only satisfactory schedule for such a condition.

SCHEDULE NO. 3

FIRST WEEK

Shifts	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	A D	X D	A X	A D	A D	A D	A D
2	B E	B E	B E	X E	B X	B E	B E
3	C F	C F	C F	C F	C F	X F	C X

SECOND WEEK

1	B E	D E	B F	B E	B E	B E	B E
2	C X	C X	C X	F X	C F	C X	C X
3	A D	A D	A D	A D	A D	A F	F D.

This schedule has worked rather satisfactorily for men at the same job and getting the same rate. It cannot be used for men on two different jobs getting different rates. Although each man gets the same "break" over a period of seven weeks, there are many objections to this schedule. The relief man must change shifts twice in one week every eight weeks, and once in eight weeks he must work eleven days straight without a day off. However, it has been found that this schedule is more satisfactory than any of the others suggested.

SCHEDULE NO. 4

FIRST WEEK

Shifts	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	A D	A D	A D	A D	A D	X D	A X
2	B E	B E	B E	X E	B X	B E	B E
3	C F	X F	C X	C F	C F	C F	C F

This schedule is similar to No. 3 except that the relief man works backward the same shifts all the time. Monday and Tuesday he works 12 to 8, Wednesday and Thursday 4 to 12, and Friday and Saturday 8 to 4. The objection is that he has only two eight-hour rests between shifts twice a week. It is not certain that a man could stand this frequent changing without sufficient rest between changes. The shift men work all the Sundays, but only six days a week.

SCHEDULE NO. 5

Shifts	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	A D	X D	A X	A D	A D	A D	A D
2	B E	B E	B E	X E	B X	B E	B E
3	C F	C F	C F	C F	C F	X F	C X

This schedule is also similar to No. 3, except that the relief man shifts forward. He has twenty-four hours off between changes. The shift men work all the Sundays and work eight days straight without a day off.

Even though the foregoing schedules provide means for working men only six days in any one week, they are not ideal. It is difficult to arrange a schedule in which every one will share alike.

With the present unemployment situation it would appear the next step toward shorter hours per week and more men employed is the five-day week. A five-day week for eight-day operation requires one extra man for each three men employed. The following schedule may be used for a five-day week.

SCHEDULE FOR FIVE-DAY WEEK

FIRST WEEK

Shifts	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1	A	A	A	A	A	A	X
2	C	C	B	B	B	B	B
3	X	X	X	X	C	C	C

SECOND WEEK

1	X	X	X	X	X	C	C
2	B	A	A	A	A	A	A
3	C	C	C	B	B	B	B

THIRD WEEK

1	C	C	C	C	B	B	B
2	X	X	X	X	X	C	C
3	B	B	A	A	A	A	A

Although the foregoing schedule is not strictly a five-day week, since each man works six days a week twice in eight weeks, it approaches a five-day week and does not have any of the objections of the six-day week schedules. Each man gets the same number of days off, with one Sunday off in four weeks. He works on an average of $5\frac{1}{4}$ days a week, and if paid time and half for Sundays receives pay for $5\frac{5}{8}$ days a week.

Either the five- or six-day week schedules provide an extra man who is ready and trained to take over the job whenever either of the other men is absent from work. The extra also eliminates the necessity of going back to eleven- and thirteen-hour shifts when one of the three men on a shift is sick. During the present period of unemployment either the five- or six-day week schedules for seven-day-week operation will provide work for one more man for each three men employed for the five-day week, and one more man for each six men employed for the six-day week.

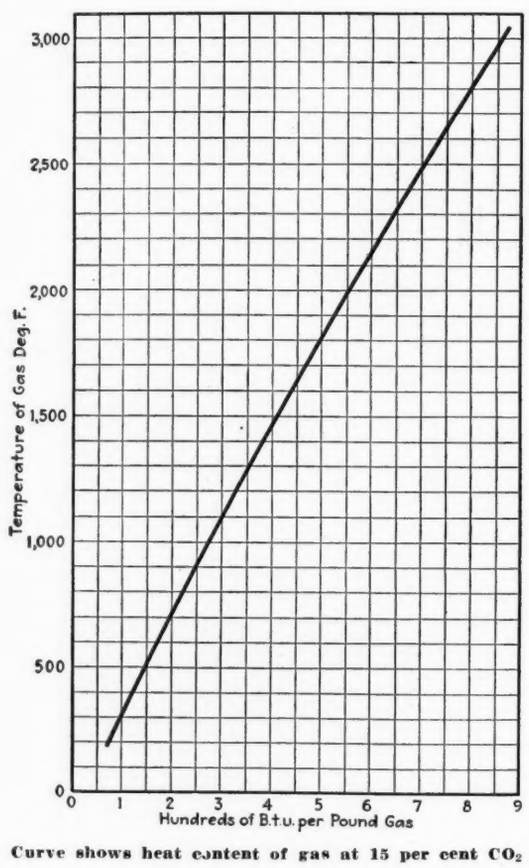
G. L. E. LINN.

Parlin, N. J.

Heat Content of Flue Gas

A GENERAL EQUATION for the heat content, above 32 deg. F., of any substance at a temperature t_1 may be written $Q = Mc\ (t_1 - 32)$, in which M is the weight of the substance and c its specific heat.

Specific heat of a gaseous mixture is found by multiplying the percentage by weight of each of the constituent gases by the specific heat of that gas and dividing the sum by 100. In computing the heat content of flue gas the mean specific heat at constant pressure should be used, for, with the exception of water vapor, the variation with pressure is negligible. The pressure range of the water vapor is small, and the water content



Curve shows heat content of gas at 15 per cent CO_2

is usually small, so that the effect of these variations in pressure on the specific heat of the gas as a whole may be neglected.

While variation in specific heat with pressure can be neglected, variation with temperature is an appreciable factor and must be given proper consideration where accuracy is desired. Curves showing the variation of the mean specific heat of the constituent gases found in flue gas with the temperature have been published several times and from several sources; so they need no further discussion.

Let us assume a fuel that will give the following products of combustion when supplied with 21 per cent excess air:

Gas	Lb. Gas/Lb. Coal	Per Cent by Weight
CO_2	2.87	21.00
O_2	0.53	3.88
N_2	9.80	71.76
H_2O	0.46	3.36

The heat content of this gas at 212 deg. F. is:

CO_2	21.00 x 0.206 =	4.33
O_2	3.88 x 0.217 =	0.84
N_2	71.76 x 0.236 =	16.90
		22.07
Heat of dry gas	(212—32) x 22.07 ÷ 100 =	39.7 B.t.u.
Heat of liquid	(212—32) x 3.36 ÷ 100 =	6.1
Latent heat	(970 x 0.0336) =	32.6
		78.4 B.t.u. per lb

At 800 deg. F. the heat content of the same gas would be:

CO_2	21.00 x 0.228 =	4.79
O_2	3.88 x 0.223 =	0.88
N_2	71.76 x 0.242 =	17.40
		23.07
Heat of dry gas	(800—32) x 23.07 ÷ 100 =	176.0
Heat of liquid		6.1
Latent heat		32.6
Heat of vapor	(800—212)x .0336 x .461 =	9.2
		223.9 B.t.u. per lb.

In like manner sufficient points were calculated to give values for the curve shown, from which it is possible to read the heat content of this gas at any temperature between 212 and 3,000 deg. F. A similar curve, constructed to suit the products of combustion of the particular fuel in use, will prove to be useful for boiler heat-balance work and for absorption checks in the field.

New York City. P. W. ANDERSON.

Power From Ice Water

TWO CORRECTIONS should be made in the article, "Heat From Ice Water," which appeared in the March 11 number of *Power*. First, I am not a Montrealer, but a Frenchman who spent a year in Canada to study the economic geography of that country. Previously, I was on the staff of the Upper Katanga Mining Union in the Belgian Congo at the Rhodesian border. The estimated cost of $15 per horsepower for the system refers only to the cost of pumping equipment, piping, and the boiler and condenser chambers. The latter were not to be made up of metal plates, but were to be simply rooms in a concrete building to obtain large capacity at low cost. Incidentally, turbine materials for operation at these temperatures would not be so expensive as for those designed to operate at high steam pressures and temperatures. The cost of the entire plant should run around $35 to $40 per horsepower.

Angers (M. & L.), France. H. BARJOT.

Blowing Down Boilers Under Load

DISCUSSIONS come up from time to time as to whether a boiler should be blown down when it is under load or after it has been out of active service for a few hours. The safety of any boiler under full pressure and load while blowing down depends, of course, upon the skill of the one who is handling such an operation.

I had sixteen water-tube boilers operating at 275 lb. pressure connected to a common header feeding engines and equipment totaling 12,000 hp. It was often necessary to blow down some of the boilers while the load was on. My procedure was to bring the water level up about 2 in. above the normal line in the gage and then blow down while the boiler was being fed.

One must be rather cautious when handling the feed and blowdown so as not to cause rapid changes of conditions. The water level should be brought up slowly while maintaining the normal steam pressure, and the level should be lowered by the blowdown in the same manner; that is, not so fast as to cause any change in the steam pressure. C. H. WILLEY.

West Concord, N. H.

Automatic Control Increases Heating System's Efficiency

SOME TIME AGO St. Paul's Church, in Salt Lake City, installed a new heating plant which uses oil as fuel. The method of heating the buildings is by indirect steam utilized in coils in a central duct system, warmed air being circulated by a motor-driven variable-speed fan. Operation of the oil burners is controlled by a thermostat located in one of the meeting rooms and set at 70 deg.

After the plant had been in operation for a short time it was found that the main fan, which started up at the same time as the oil burner, delivered cool air instead of warm air to the various church rooms. This air continued cool until such times as the oil burner had caused enough steam to be generated in the boiler to heat the coils in the air duct. This was objectionable, and a remedy was found in the following arrangement:

A standard magnetic starting switch was installed to start the motor-driven fan, and so arranged that the motor would start from any desired speed setting. The main thermostat in one of the meeting rooms was so connected that it would start the oil burner in the customary manner and at the same time actuate a time-delay relay the contacts of which were used to close the magnetic switch for starting the fan motor. When the temperature in the main room drops to, say, 68 deg. the thermostat makes contact and starts the fire under the boiler, and then the fan, depending upon the setting of the time-delay relay, starts up several minutes later, forcing air over the now heated steam coils. When the room reaches 70 deg. the oil burner is automatically shut off and the time-delay relay is again energized, and at the end of 15 min. will shut down the fan. This over-running of the fan after the fire is out recovers the stored heat in the steam coil and thereby increases the efficiency of the steam. E. BACHMAN,

General Electric Company.

Salt Lake City, Utah.

From Among Readers' Problems

Conducted by

L. H. MORRISON

AUTO - TRANSFORMER BLOWOUT — *A number of motor-generator sets in our plant are started by hand-starting compensators consisting of an auto-transformer winding and switching device all self-contained within a metal case. The motor-generator sets vary in capacity from 100 to 300 kw. They are driven on 2,300-volt, 3-phase, 60-cycle induction motors. While starting one of the motors one of the operators was severely burned about the face and hands due to a blowout in the auto-transformer winding.*

Is it considered safe practice to use this type of starting apparatus for controlling motors with the given electric characteristics? What practical electrical test can be made to forestall breakdown of the auto-transformer winding and consequent injury to operating personnel? One well-known manufacturer of electrical control apparatus will furnish the same type of motor control for identical conditions but with a so-called dead-front safety panel. Does this not indicate that the type of control now used is unsafe? A.F.A.

It can hardly be said that a 2,300-volt auto-transformer is dangerous. Of course, there is an element of danger around all electrical power equipment. It is not considered unsafe to work around high-voltage transformers, but there is a remote possibility that an explosion may occur when someone is passing by. Such an explosion would probably result in death for those near at hand.

The case to which you refer, where the auto-transformer exploded, is a rare one, particularly if a proper maintenance schedule is followed with the equipment. If the auto-transformers are used frequently the contacts should be inspected once every month, and the oil tested at least once a year. The two articles on "Inspection and Maintenance of Transformers," that appeared in the March 4 and 11 issues of *Power* may be considered as being also applicable to auto-transformers. Those articles dealt extensively with the care of transformer windings and the oil.

Because one manufacturer has brought out a type of control apparatus that operates from a dead-front switchboard, it does not follow that all other types of equipment are unsafe. There are thousands of manual-type auto-transformers for starting motors that have never given such trouble as that to which you refer. Your experience is an unusual one. Of course, if the windings are not kept clean, the contacts kept in good condition, and the oil maintained to have a high insulating quality, there should be no danger. If the equipment is kept in proper condition there seems to be no reason to feel alarmed about its developing serious trouble.

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COAL VALUE DEPENDS ON MORE THAN ASH AND B.T.U.—*Which would be the more economical to purchase, coal having 13,000 B.t.u. per pound and 17 per cent ash costing $2.75 per ton of 2,000 lb. laid in the boiler room, or a coal containing 14,000 B.t.u. per pound with 8 per cent ash costing $4 per ton of 2,000 lb. laid in the boiler room?* C.M.

The relative economy is not susceptible of solution on a basis of heat per dollar, for in each case the cost of handling the coal, stoking, handling ashes and clinker, the percentage of combustible in the refuse and cost of furnace repairs depend on the characteristics of the fuel and the facilities and management of the plant.

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POUND IN DIESEL ENGINE—*In our Diesel engine one cylinder pounds when the piston is at the upper dead center at the end of the exhaust stroke. What is the cause?* L.G.

Without more definite information as to make, etc., of the engine, two possible causes can be outlined. If the crankpin bearing is slack, as the piston moves upward on the exhaust stroke, and the crank turns and starts downward, the inertia of the upward moving piston causes the piston rod and crank bearing to strive to continue moving upward. As a result, the lower part of the crankpin bearing strikes against the crankpin, causing a pound. On the compression stroke the air pressure within the cylinder overcomes the piston inertia, and the upper half of the bearing is held snugly against the crankpin as the piston reverses its travel.

A second cause may be the striking of the piston against the cylinder head due to a slack crankpin bearing. This, however, is possible only in engines where the clearance between head and piston is very small. In either case decreasing the crankpin clearance should cause the pound to disappear.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

I SHOULD like to hear from some of POWER's *readers as to how they deal with the problem of motor and control obsolescence. For example, if an old motor, started on reduced voltage, burns out, is this sufficient reason to replace the old equipment with a new motor that can be started on full voltage?* N.E.W.

OBSOLESCENCE is not a sufficient reason for changing equipment, as there are generally other things involved, such as increased maintenance charges, lost time in outages, inability to obtain repair parts, etc. Assume a compensator on a 50-hp. standard squirrel-cage induction motor has the coils, contacts, overload and no-voltage relay coils and leads so badly damaged that they need renewing. It will be found considerably better to scrap the equipment and purchase a magnetic switch with push-button station and start the motor on full voltage, providing the power company is agreeable and the application is of such a nature that the strain of full-voltage starting will do no damage. There need be no fear of starting a standard squirrel-cage induction motor directly across the line in so far as the motor is concerned. One

advantage in changing from a compensator to a magnetic switch on any application where the starter must be in sight of the motor is that the magnetic starter may be located at any convenient remote point, the push button being the only apparatus in sight of the motor.

For example, it is more economical to scrap an obsolete motor where considerable trouble from burnouts is encountered. If the motor is over 35 hp. and of the semi-closed slot type, three burnouts will pay for a new open-slot motor that has coils which can be property impregnated and easily removed and replaced. The cost of rewinding a 1-hp., 3-phase motor is approximately 70 per cent of the cost of a new motor.

In most industrial plants a burnout is due to a cause that can be remedied. For instance, if the motor is in a damp location where it is apt to be flooded, it may easily be protected with a metal hood, or, better still, replaced by a totally inclosed motor, the original motor being used on some other application.

In a location subject to high temperatures, the windings may be asbestos- or enamel-covered.

If the motor does not suit the application as to rating, or other reason, it may be substituted for one that will. A survey will often show that a 50-hp. and a 75-hp. motor can be interchanged and both give more satisfactory results and a saving in power.

I should say that, from my experience in plants with from 300 to 500 motors of all sizes, it will pay to rewind any motor except those of fractional-horsepower sizes, with the probable exception of such cases as previously cited. Fractional horsepower motors when badly burned will usually cost more to rewind than a new motor.

A close check of maintenance, repair, and service costs is the only sure way to arrive at the solution to this question. When the average cost per unit motor exceeds $30 per year, and the average cost per unit horsepower exceeds 50c. for all repairs, maintenance, inspection, and oiling for a large industrial plant, a survey should be made and the cause investigated. H. E. STAFFORD,
Electrical Engineer,
Provincial Paper Company, Ltd.
Port Arthur, Ontario.

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OUR EXPERIENCE with full-voltage-start motors would indicate that the answer to the question is "yes." We were skeptical at first and doubted if it were desirable to use this type of motor, because the starting current might not be within reasonable limits. However, there are now several full-voltage-start motors on our lines and they are very satisfactory. The starting characteristics are equal to or better than the reduced-voltage-start type. They are being used on pumps up to 25-hp.

It is doubtful if these motors would be satisfactory for starting extremely high-torque loads, but neither is the compensator-type motor. We find that the absence of the surge that occurs between the high and low speeds, experienced when a compensator is thrown from the starting to the running position, is a decided advantage.

E. A. ROBERTS,
Southwestern Public Service Co.
Carlsbad, N. M.

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THE QUESTION assumes that the conventional type of squirrel-cage motor has become obsolete and that the new type of high-reactance or line-start motor is superior to the other in its operating characteristics, both of which are incorrect. The chief advantage in the high-reactance motor is its more simple starting equipment, resulting in an appreciable saving in the purchase and installation costs.

Where the starting equipment is already installed and in good working order, it would probably be best to use the regular squirrel-cage motor rather than to tear out the old equipment. The matter of choosing a motor for a certain application is usually more involved, and is settled by factors other than whether a motor can be started across the line, although for new installations the line-start motor is, of course, the less expensive.

Slow-speed synchronous motors, in addition to their ability to start on full voltage, have relatively high efficiency, their power factor can be made most any desired value, and they can be used for power-factor correction and for dynamic braking. R. JOHNSON.
Crowheart, Wyo.

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SO MANY factors enter into the obsolescence of equipment that each case has to be judged by itself. The cost of rewinding an old squirrel-cage induction motor will run from 50 to 75 per cent of the cost of a modern line-start, anti-friction bearing motor.

In favor of the new type of motor is its simplicity and the flexibility of control. It should be borne in mind that with push-button control, motors may be stopped or started from several different locations. Another factor is the wall, ceiling, and floor space saved by the modern compact units. As the new squirrel-cage motor does away with the compensator, it eliminates one major item of maintenance cost. Also, these motors, even of the open type, have much better ventilation.

About the biggest objection to replacement of obsolete equipment is the greater cost of new equipment over the cost of a rewinding of an old motor. Also, it should be remembered that the installation of new motors may entail changes in the conduit layout to the motor. Mechanical drive from the motor to its load may have to changed (such as the necessity of wider pulleys and belts or heavier gears and chains).

Financing the purchase is another factor to be remembered. Occasionally what cannot be afforded now will be a good investment six months hence. It is my opinion that under most conditions the replacement of obsolete electrical equipment, especially after it has given ten years' service, is to be recommended.

Denver, Colo. CARL A. WAGNER.

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I SHOULD say that it may be necessary to have this motor rewound or replaced by a motor of similar design, since a starting device has already been installed, and this starter may have no other use in the plant. The compensator or auto-starter may be dispensed with entirely and a high-reactance motor installed. These new motors have desirable characteristics and may be used in sizes up to 1,000 hp. with smooth acceleration and cause no damage to the driven machinery.

Since all the facts are not given for a complete solution of the problem, I can only say it is a cost problem to decide which is the most economical installation. NOBLE WATKINS,
Electrical Engineer.
Pittsburgh, Pa.

A Question for Our Readers

IN CONSIDERING the relative values of expansion loops and expansion bends, to care for expansion in steam piping, the following statements seem correct:

If a bend and a loop were each blanked at each end and hydrostatic pressure applied, the distances between the flanges would increase in the case of the bend and decrease in the case of the loop. The friction loss due to flow is less in the loop than in the bend. The greatest dimension of the loop may be less than the greatest dimension of the bend to secure the equal flexibility under working pressure. The bend giving equal flexibility with a loop, is costlier, harder to make, and requires more pipe.

If the statements are true, why are bends almost universally chosen? These facts surely more than balance the disadvantage of offset flanges, and the loop can be made to bring the flanges in line. W.T.H.

Suitable answers from readers will be paid for and published in the July 15 number.

Reducing Friction Losses In Rectangular Duct Elbows

In the January 8, 1929, number of *Power* an article by B. L. Spivak explained why square bends reduce elbow losses in rectangular ducts. It was abstracted in the March 2 number of *Die Wärme* and later discussed in the October 19 number. This is an abstract of the latter.

By H. NIPPERT

THERE are widespread misconceptions regarding stream-line formations and losses occuring in rectangular duct elbows. By changing the shape of the elbow, it is possible to reduce to a minimum losses due to a change in direction of flow.

Stream-line phenomena are complicated and cannot be generalized from the observed character or behavior of a single stream-line. The flow velocity profile within a straight duct of uniform cross-section is violently distorted within a bend or elbow. The maximum flow velocity which takes place within the center core of a straight duct is diverted toward the outer radius of the bend, and a lesser flow velocity takes place along the inner radius, see Fig. 3. The distortion of the original velocity profile increases with the sharpness of the bend. The flow is further distorted by centrifugal force into a series of cross flows, which are superimposed on the main flow through the bend. This distortion is made up chiefly of two rotating flows, both of which start at the center and spread out toward the bend walls, where they are again united and return to the center. One of these passes across the upper side of the channel, while the other passes across the under side. This rotating motion, as well as the distortion of the velocity profile, continues after the bend for a considerable distance (more than ten times the diameter of the duct), until eliminated by the frictional resistance of the walls.

Pressure distribution within the bend corresponds with that resulting from ideal stream flows through the bend in spite of the great distortion of the flow velocity profile. It will not be appreciably affected by changes in the velocity. An overpressure occurs exactly at the crest of the outer wall, and a corresponding low pressure at the inner wall. A pressure rise must occur in the flow from the inlet to the crest of the outer radius and again from the crest of the inner radius to the outlet, as indicated by P_a and P_i in Fig. 2. These pressure changes produce whirls in the fluid at the locations shown by the shaded areas which contribute to the losses.

Losses occurring when a fluid flows through a bend are due to several causes; the surface friction along the

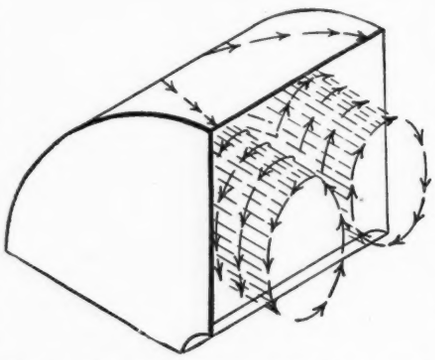

Fig. 1—The cross-section shows how cross flows are superimposed on the axial flow

wall, the whirls or eddies produced by the tendency of the flow to break away from the wall, and the cross flow resulting from the rotary motion. These losses vary individually in various proportions with different types of bends.

In computing numerical values of the losses, the following factors were taken into consideration:

The ratio of the radius of the bend to the diameter or width of the opening, $\frac{r}{d}$ or $\frac{r}{b}$, and the form of the cross-section or the ratio of the height of the opening to the width of the opening, $\frac{h}{b}$.

In the experiments made by the author the minimum losses occurred when the ratio $\frac{r}{b}$ = about 4.5.

Mr. Spivak states that he had found the value of this ratio for best conditions to be about 6.0. This higher value appears to be possible and does not represent a very great deviation, for the reason that the secondary losses decrease rapidly as the radius of the bend increases to a point where the losses are at a minimum. It is therefore difficult to determine the exact minimum experimentally.

In practice, with ratios from 4 to 4.5 it is observed that losses in bends are about equal to those occurring in straight pipes of equal length, so that nothing will be gained by increasing the radius of the bend. So it is recommended to limit the radius to 4.5 × the width of the duct, especially because of the saving in space. In 90-deg. bends it is important to consider the ratio $\frac{h}{b}$. A value of about 2.0 was found to be the most advantageous, whereas Mr. Spivak gives this ratio a value of 4.0. These values contradict. Experiments plainly indicated that the ratio should lie somewhere between 2 and 2.5. It seems unlikely that the value of this ratio, which equals 1 for a straight duct, should differ so materially in a bend.

Experiments showed that a bend of uniform cross-section does not have the smallest losses, but that the losses are considerably reduced if the cross-section of the bend is enlarged at the crest of the bend. Losses may be reduced as much as 35 per cent by this change in form. The degree of enlargement should vary with different types of bends up to a maximum increase of 40 per cent above the inlet cross-section. This fact has not been generally known, but its application in practice will result in a considerable

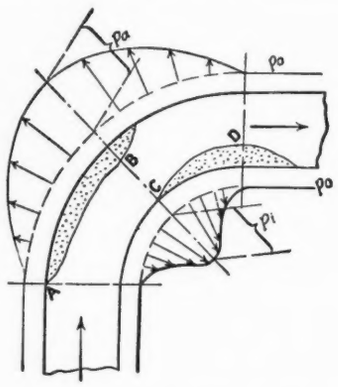

Fig. 2—The pressure rises at the outer wall from A to B and from C to D along the inner wall. Shaded areas indicate the formation of whirls

saving in energy when transporting gases or liquids through bends.

The improvements suggested by Mr. Spivak — to install curved vanes in square bends—merely divides the bend into a series of thin bends, which, however, in spite of the added surface, produce a material increase in the

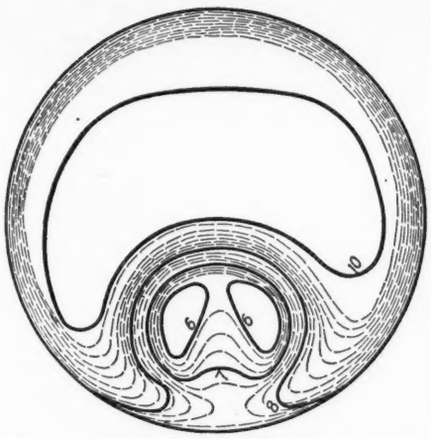

Fig. 3—Lines of equal velocity in the cross-section of a round bend. These lines become concentric circles in a straight round duct. The figures represent the velocity in meters per second

efficiency of the normal square bend. This suggested improvement is not new. The idea was put into practical use at the Aerodynamic Institute in Goettingen during 1908 and 1909. There the application was limited to ducts in which square bends of low efficiency were installed. At any rate, older experiments have shown that the installation of curved guide vanes in fairly good bends did not improve their efficiency, but, on the contrary, contributed to the losses.

The 80 per cent improvement in efficiency stated by Mr. Spivak is possible only in the case of a poorly designed square bend. The Goettingen experiments showed that the guide vanes consumed about 15 to 20 per cent of the kinetic energy of the flow. Theoretically, the higher efficiency obtained by the use of guide vanes is due to the subdivision of the square bend into a number of smaller flows in which the differences in velocity and pressure on the outer and inner radius will not be so great, and, therefore, are less important in creating flow losses.

SUMMARY

Losses in flow through bends will be at a minimum under the following conditions:

Where, in long radius bends, the maximum ratio between the radius and the width of the duct is 4.5.

Where the bend is shaped to gradually increase the cross-sectional area from the inlet to the crest of the bend and to gradually diminish it toward the outlet.

Where the maximum ratio between the duct height and width is 2.0 (for rectangular ducts).

Standard bends that have been in use involve a material increase in the energy loss. The very high losses occurring in a square bend, which may be required by the structural conditions, can be materially reduced by the use of guide vanes, to approach the losses obtained in a standard bend.

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Propeller Pumps Urged for Emergency Marine Service

IN VIEW of its ability to effectively handle large quantities of water under low heads, the propeller-type pump is being advocated for emergency bilge pumping service in marine work.

"There is nothing new in the suggestion of fitting emergency bilge pumps in vessels, and of course the practice of fitting bilge suctions to the condenser circulating pumps in engine rooms has been standard practice for many years. However, the fitting of emergency bilge pumps in other compartments has never received any serious consideration, partly for the reason that past marine disasters were not considered from the viewpoint of the time element involved but mainly because, before the introduction of steam turbines, electric motors and high-speed propeller pumps, there were no pumps available of sufficient capacity to be of real value."

Amplifying this statement in the April 1 number of *Marine Journal*, H. F. Schmidt, consulting engineer of the Westinghouse Electric & Manufacturing Company, cites the "Titanic," of 66,000 tons displacement, which sank in four hours. This ship could have been kept afloat at normal water line if equipped with emergency pumps in each compartment having a capacity of 16,000 tons per hour.

The arrangement suggested by Mr. Schmidt is to have the pumps turbine driven, the turbine equipped with a float-operated valve instead of a speed-controlled governor. Thus the turbine would start when a predetermined water level had been reached. The characteristics of the propeller pump are such that shutting either the suction or the discharge increases the power required to drive it, so that in either case the pump would slow down below normal. On the other hand, if the discharge head decreases, the power required to drive the pump decreases while the speed and capacity increase. Such a characteristic is ideal for emergency bilge pump service.

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RECENT EXPERIMENTS in Soviet Russia have shown that a certain clay obtained in large quantities as a by-product of coal mining, particularly in the Bobrikov field in the Moscow coal basin, is high enough in aluminum content to make it a practical source of this metal. It will be possible, according to expert opinion, to establish an annual production of about 10,000 tons of metallic aluminum from the ashes obtained in the planned 150,000-kw. power plant in the Moscow coal basin.

Combination Power and Heating Plants in Britain

IT IS generally recognized that the advance in power station practice during the past decade includes the increase in thermal efficiency of 20 to 25 per cent from the raw coal to the switchboard. The present average of 16 to 17 per cent represents a considerable advance over former practice, though many stations must be operating with less than 16 per cent.

The whole subject is very much to the fore in the United Kingdom at the present time, but in the development of the national "grid" system there is a possibility that other important needs may be overlooked. There are, for example, many industries using low-pressure boiling and process steam, such as bleaching, brewing, calico, printing, celluloid manufacture, papermaking, dyeing, hosiery-making, laundries, sugar refining, and tanning, to mention only a few, where a combined steam-heating and power plant will operate at an over-all efficiency of 50 to 65 per cent from the raw coal to the actual place of use even for a very small installation.

The reason is that under such conditions there is no latent heat of steam loss, whereas in an electricity station with condensing turbines 60 per cent of the heat of the coal is lost in the cooling water.

Coal to the extent of at least 30,000,000 tons per year is burned in Britain to provide low-pressure process steam, as compared with 9,000,000 tons in power stations. The proper scientific method would appear to be to develop to the utmost extent the use of back-pressure or pass-out steam engines or turbines in connection with this huge annual consumption of coal operating at 50 to 65 per cent thermal efficiency, and generate electricity at a fraction of the cost of a power station using condensing steam turbines.

North Carolina Ranks Third in Water Power

THE State of North Carolina holds third place among all the states in the development of water power, according to a statement issued by the division of water resources and engineering of the department of conservation and development. The state is exceeded in this respect only by California and New York.

North Carolina's development of hydro-electric power represents 6.9 per cent of the nation's total, with California having 16.7 per cent and New York 13.1 per cent. Alabama is fourth.

The output from North Carolina's electric plants in 1929 was 13.6 per cent greater than that for 1928, being over 2,500,000,000 kw.-hr., of which 93 per cent was produced by water power. The output in 1929 was 248 per cent greater than that of 1920, 10 years ago.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Adjustable-Orifice Burner for Pulverized Coal and Blast-Furnace Gas

IN BURNING certain fuels, such as pulverized coal, blast-furnace or coke-oven gas, a uniform velocity leaving the burner irrespective of the amount of fuel burned has been found to be desirable. Also, when turbulence or agitation is necessary to complete the mixing process with the air of combustion, ability to maintain this turbulence regardless of the amount burned and without the use of an outside source of power is an important feature of any fuel burner.

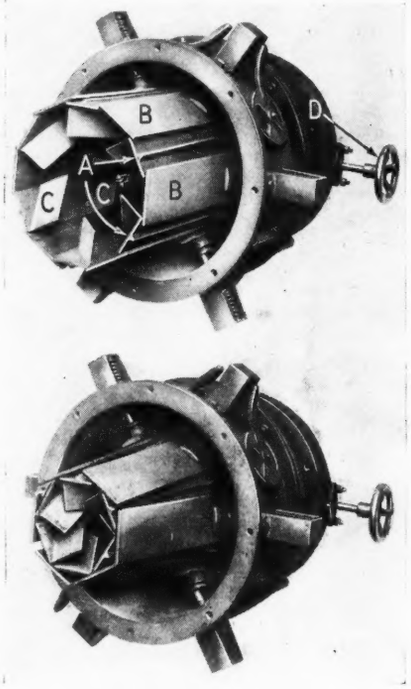
A burner of the adjustable-orifice type, designed especially to meet these requirements and to obviate the need of a number of small burners to obtain good combustion on variable loads, has been introduced recently by the Ashmead-Danks Company, 7016 Euclid Ave., Cleveland, Ohio.

From a study of the accompanying illustrations the method of controlling the velocity at the point of issue from the burner and at the same time maintaining the necessary turbulence to give the required mixing of fuel and air will be readily understood.

Referring to the view which shows the burner with the nozzle in the wide open and closed positions, the adjustable portion of the burner is composed of twelve blades (6 inside blades *A* and 6 outside blades *B*), all hinged at the inlet end of the cone, giving a fixed diameter at that end. The inside blades *A* carry the vertical turbulating vanes *C*, two in number, on each blade. The outer blades lap over the inner blades and are constructed to ride the finished edges of the inside blades, forming tight joints along their entire lengths. By means of springs shown on the outside, the outer blades are made to follow the inner blades, which, in turn, are controlled by an operating mechanism attached to the handwheel *D*. After removing a section of the cleaning ring *E*, which is made in halves, any blade may be replaced without dismantling or removing the burner from the furnace.

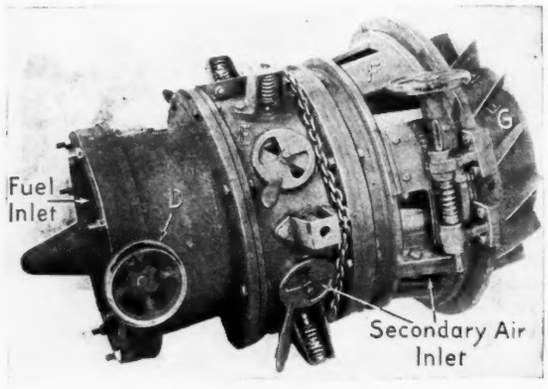
Secondary air is admitted to the burner through adjustable openings in the ring *F*. The air is made to flow spirally along the exterior of the nozzle sleeve *G* in a direction opposite to that of rotation of the fuel, and primary air is admitted through the center. When preheated secondary air under pressure is used, the secondary-air ring *F* is inclosed in a steel casing, and the operating stem for the ring is extended and passed through the casing.

An important feature of the burner is the provision made in the design for readily changing the various adjustments from manual to automatic control.



Views of the burner, with the outlet end of the orifice in the wide open and closed positions

The burner is made in four standard sizes, designated A, B, C, and D. Size A has a maximum capacity of 7,320 cu.ft. of blast-furnace gas or 3,978 lb. of coal an hour, and size D a maximum capacity of 74,400 cu.ft. of gas or 41,072 lb. of coal an hour. The two intermediate sizes have corresponding capacities.

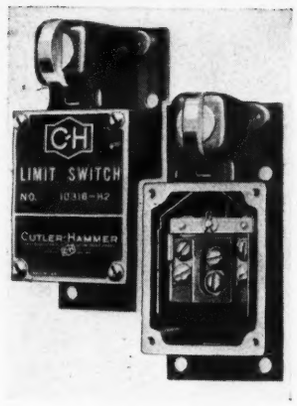


Burner assembly, showing controls for fuel-orifice opening and secondary-air inlet ring

Small Limit Switch

SINGLE-POLE limit switch for general service and suitable for use on elevators, conveyors, and other equipment, to start, stop or reverse the motor at its limits of travel is announced by Cutler-Hammer, Inc., 190 12th St., Milwaukee, Wis.

Two types are furnished: one with normally closed contacts, which are opened when the operating roller is depressed, and the other with nor-



Open and enclosed view of limit switch

mally open contacts, which are closed when the roller is depressed. Double-break contacts with silver-rivet contact tips reduce pitting and insure long life. The movable contact is connected to the machined steel operating roller through a sliding shaft and a heavy bakelite strip.

Vibration Insulating and Sound-proofing Material

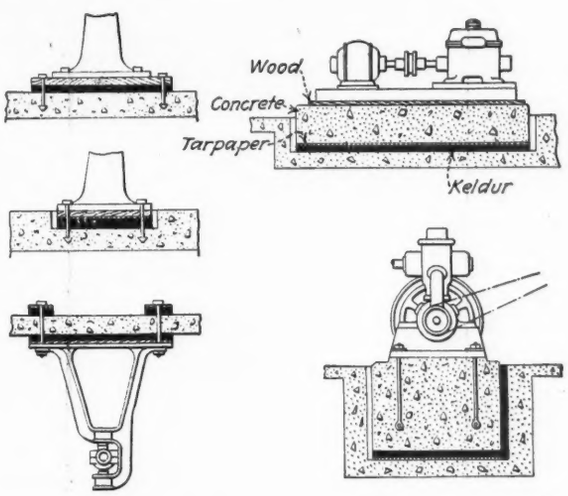
A RESILIENT, rubber-like material held between coarsely woven jute cloth or burlap is being offered for vibration insulation purposes by the International Products Corporation, 425 Van Buren St., Milwaukee, Wis., under the trade name Keldur. Like rubber, it deadens noise and checks vibration, but it is not subject to deterioration in the presence of oil, and will not harden, according to the manufacturer. It inhibits mechanical and chemical disturbances. The initial compression varies between 1 and 6 per cent.

The material can be used for either light or heavy equipment, such as motors and generators, presses, transmission equipment, prime movers, and all kinds of machinery where noise and vibration are to be held at a minimum. It can also be used as a soundproofing material for doors and walls and as a floor covering over concrete.

Keldur comes in sheets 28x36 in. or 29½x40 in., and in thicknesses of ¼, ⅜ and ¾ inch. One square foot of the ⅜-in. material weighs 3⅓ lb. Several sections can be laid side by side if one sheet is insufficient to cover the base of the machine. Two thicknesses of the material are used where vibrations are particularly severe.

It is not necessary to insulate the entire base of the machine. Better practice is to cut the material into strips, according to the frame of the machine, allowing a little to project around the edge. Wooden strips 1¼ to 2 in. in thickness should be placed between the frame and the Keldur, preferably connected together in the form of a frame. If, for example, a motor is to be insulated, two planks are placed under the sliding track and the insulating material is tacked to the planks, which are bolted to the floor, wall or ceiling.

When the machine is fastened through screws or bolts, the holes in the boards should be larger than the screw diameter, to allow a slight amount of lateral freedom, disrupting rigid contact between the floor and machine frame. Before the machine is set up, the cut edges of Keldur are lacquered or oiled to preserve it against dampness. When the material is used in walls or in concrete foundation, as in supporting heavy machines, it is inclosed in tar paper to prevent mortar and dampness from penetrating.

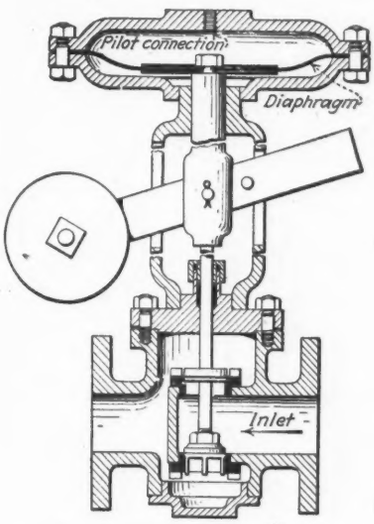


Typical examples in use of "Keldur"

Direct-Acting Regulating Valve for Pressure and Vacuum Service

DESIGNED for either low-pressure or for vacuum service, the balanced regulating valve illustrated, put out by Strong, Carlisle & Hammond Company, 1392 West Third St., Cleveland, Ohio, is of the direct-acting pressure type suitable for operating pressures up to 100 pounds.

As will be apparent from the drawing, movement of the diaphragm is imparted directly to the valve stem, force exerted by the diaphragm being opposed by a weighted lever. When used for vacuum service the weight is used on the free end of the lever, as illustrated, and for pressure service it is changed to the pivoted end.

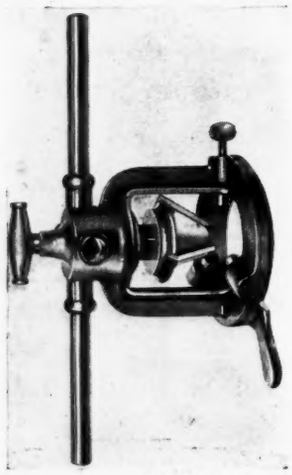


Valve adaptable to pressure or vacuum service

Of semi-steel construction with bronze seats and stem, the valve may be installed either as shown or in an inverted position. Operating pressures range from, inlet maximum 100 lb., outlet or reduced pressure maximum 15 lb. gage, to minimum of 10 in. vacuum. The valve is available in several flange types in standard pipe sizes from 1½ to 8 inches.

Four-Inch Pipe Reamer

A FEATURE of the No. 414 reamer for 4 in. pipe recently brought out by the Oster Manufacturing Company and the Williams Tool Corporation, Cleveland, Ohio, is a screw feed the pitch of which is so designed that great pressure is exerted by the reaming blades. This eliminates necessity of pushing



Four-inch reamer designed for power or hand operation

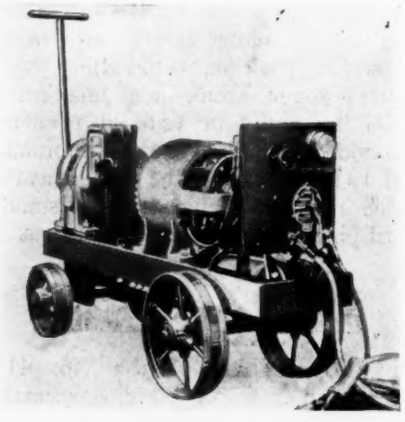
against the tool to obtain sufficient pressure for a thorough reaming.

Although this reamer was designed to be used primarily with the No. 414 Power Boy, put out by the same company, two additional handles may be used for hand operation. Reaming blades are renewable, and the body of the tool is made of malleable iron.

100-Amp. Welder for General Repair Work

DESIGNED especially for small jobs and repair work in general, the 100-amp. Model S welder brought out by the Wilson Welder & Metals Company, Inc., Hoboken, N. J., is available with three types of drives: electric motor, gasoline-engine and belt drive.

The unit has a rating of one hour at full load without more than a 50 deg. C temperature rise, and has a welding range of 30 to 125 amp. It is relatively light in weight and suitable for operation in limited space.



Type S 100-amp. welder

Crawler-Mounted Flight Conveyor

A RECENT ADDITION to the line of coal-handling equipment put out by Barber-Greene Company, Aurora, Ill., is the model 57 crawler-mounted flight conveyor illustrated.

Built in three boom lengths of 24, 30, and 39 ft., the machine has a three-unit chain drive. Each chain unit is of a fixed length, and chain tension does not vary with change in the boom's position. Protection against overload strains is provided by an overload release sprocket mounted on the head shaft. This sprocket is made in two parts, the outer part, which carries the drive chain, and the inner part, which is keyed to the head shaft. The inner part is held in normal driving position by two springs. When an overload occurs on the flight line, the spring compresses, allowing the driving part to turn freely until the overload is relieved. Flights are of $\frac{1}{4}$-in. steel and are cupped to exert a digging action. Capacity is rated at one ton of coal a minute.

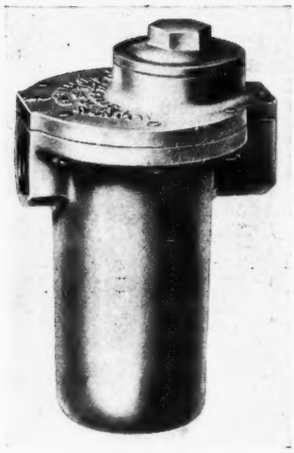
Flight conveyor with crawler-type traction

Blast Trap for Unit Ventilators and Heaters

A SMALL, light-weight, high-capacity trap designed especially to meet the requirements of unit ventilators has been brought out by the Illinois Engineering Company, Chicago, Ill.

Designated Series 17, the trap embodies important features of the Series 18 combination blast trap made by the same company. A bucket-operated valve handles the condensation, and a thermostatically controlled air vent bypass is incorporated in the cover.

The bucket, with valve stem attached, is carried from a long guiding sleeve arranged to move vertically in a central discharge tube, the mechanism being designed to give positive



Series 17 combination blast trap

snap action and eliminate wire drawing. The air venting element is mounted in a circular chamber on the body cover. Removal of the cover from this chamber not only permits of inspection of the diaphragm, but also inspection and removal of both the water-valve seat and air-valve seat.

Furnished in $\frac{3}{4}$-in. pipe size, with capacities ranging from 150 lb. of hot condensate an hour at 1 lb. pressure to 500 lb. at 10 lb. pressure, the trap has an over-all height of $6\frac{1}{2}$ in., an inlet to outlet measurement of $4\frac{1}{2}$ in., and a total weight of less than 5 pounds.

Hardened Copper Alloy

A SUBSTITUTE for phosphor bronze, mangenese bronze and gun metal, known as "P.M.G." metal, developed by Vickers-Armstrong, Ltd., Barrow-in-Furness, England, is now available in this country through the Driver-Harris Company, Harrison, N. J.

The new metal is a hardened copper alloy in which the 10 per cent tin is replaced by 10 per cent of a special hardener. It is especially suitable for use where high tension strength, considerable elongation and resistance to abrasion are required.

NEWS of the FIELD

Spot News

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WITH THE SETTLEMENT *of all objections raised by Arizona at the recent hearings on Boulder Dam except the question of whether Los Angeles and the Metropolitan Water District have the power to enter contracts, it is expected that the initial $10,660,000 appropriation for the dam will have been approved by the House by the time this appears in print.*

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A BILL *placing natural gas pipe lines under the jurisdiction of the Interstate Commerce Commission, or another branch of the federal government, is being prepared by the Kansas Public Service Commission and will be introduced by Senator Allen. At the same time the public service commission will proceed at once with a general investigation of the gas situation in Kansas.*

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WHETHER OR NOT *power will be developed at Great Falls on the Potomac River is left to the future determination of Congress, according to the terms of the Cramton-Capper bill which was signed by President Hoover on May 31. The act provides only for park development in the gorge.*

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FORMATION *by an American and European banking group of British and International Utilities, Ltd., a public utility holding company with wide international ramifications, was announced in London June 3. Count Volpi, former Italian Finance Minister, will be chairman of the new company, which has behind it the Electric Bond and Share Company, Bonbright & Company, Field, Glore & Company and the recently organized European Electric Corporation.*

American Delegates Sail on Resolute for World Power Conference

Forty-three prominent engineers and executives in party headed for Berlin—Details of radio hook-up with N.E.L.A. convention announced

FORMING part of a large group of Americans who will attend the World Power Conference to be held in Berlin from June 16 to 25, 43 engineers and industrial executives left New York June 4 aboard the Hamburg-American liner Resolute for Germany. Most of the delegates were accompanied by members of their families.

Prominent in the party was Dr. Walther Parey, representative of the German National Committee which is making arrangements for the Berlin sessions. Dr. Parey has been in the United States for several months assisting the American Committee in preparing for participation of United States delegates in the conference. Professor Robert Sibley of the University of California was designated as chairman of a committee to arrange for entertainment of the Americans aboard the Resolute. He went to Berlin as an official representative of the United States Government at the conference and will be chairman at a session devoted to "Electricity In the Crafts and Industry."

Two other official representatives of the United States Government, designated by the State Department, also sailed. They are David B. Rushmore, New York consulting engineer and member of the executive board of the American Committee for the World Power Conference, and Ely C. Hutchinson of New York, editor of *Power*.

As the ship sailed Dr. Parey received the following telegram from Dr. K. von Lewinski, German Consul General at New York, and Dr. W. Becker, German Commercial Attaché: "To all the distinguished members of the American delegation who will participate in the World Power Conference at Berlin, as well as to their relatives, we convey our sincerest wishes for a pleasant journey and delightful stay in Germany. Your delegation represents the vast practical experience and high standing of technical science in American engineering. We are sure you will contribute largely to the success of this international gathering, and that the most valuable interchange of ideas and experience will spur on the engineers of all participating countries to even greater achievements."

United States Official Delegates, left to right: Robert Sibley, David B. Rushmore and Ely C. Hutchinson

When the Resolute arrives at Southampton, England, the American delegation will be met by Messrs. Deters and Goos, directors of the Hamburg-American line, who will personally conduct the party to Berlin.

Conference, N.E.L.A. in Radio Hook-Up

AT TWENTY minutes to five, Eastern Daylight Saving Time, on the afternoon of Wednesday, June 18, Thomas A. Edison, sitting at a desk in his laboratory at West Orange, N. J., will conclude the most extraordinary program of international communications ever attempted. Speaking into a microphone he will address, simultaneously, two gatherings being held 7,500 miles apart—the 53d convention of the National Electric Light Association at San Francisco, and the representatives of 50 nations attending a banquet in Berlin, Germany, held in honor of the World Power Conference by the German delegation. Others who will precede Mr. Edison on the transcontinen-

Some of the 43 engineers and executives, with members of their families, who sailed on the Resolute, left to right: C. W. E. Clarke, Ely C. Hutchinson, Prof. Robert Sibley, Dr. Walther Parey, John Hunter, Mrs. Hunter, David B. Rushmore, Mrs. Kuhn, L. C. Marburg, Mrs. John R. Freeman, L. W. W. Morrow, Mrs. Arthur M. Greene, and Prof. Arthur M. Greene

tal, transoceanic program are Owen D. Young, Lord Derby, Senator Guglielmo Marconi, M. S. Sloan, Dr. Carl Koettgen, and Dr. Oskar von Miller.

Broadcast over short wave length, the program will be heard in Japan, Australia, New Zealand, Europe, and, theoretically, anywhere in the world. In this country the National Broadcasting Company will broadcast it over the Red and Blue networks.

The program will be opened by Phillips Carlin, announcer, from the San Francisco exposition auditorium. After a brief statement explaining the program he will call the roll, asking for responses from London, Berlin, and West Orange.

Mr. Carlin will then introduce Matthew S. Sloan, president of the N.E.L.A., who, speaking in San Francisco, will address the World Power Conference in Berlin. Immediately upon the conclusion of his talk a Berlin announcer will cut in, introducing Dr. Carl Koettgen, presiding at the banquet being given to the delegates. Dr. Koettgen will respond to Mr. Sloan.

Mr. Carlin, at the microphone in San Francisco, will then cut in and introduce a London announcer, who, in turn, will introduce Lord Derby, first president of the World Power Conference and head of the famous family which founded the great Derby racing classic. Lord Derby from a studio in Surrey, in the suburbs of London, will simultaneously address both the San Francisco convention and the Berlin conference.

As soon as Lord Derby in England concludes, Mr. Carlin, in San Francisco, will introduce the Berlin announcer, who, in turn, will introduce Dr. Oskar von Miller, honorary president of the World Conference, succeeding Lord Derby. Dr. von Miller will address both the Berlin and San Francisco conferences and will be followed by Mr. Carlin introducing the London announcer. Senator Marconi, who was the first scientist to ever send an intelligible message by radio across the Atlantic, will then speak.

Following Senator Marconi, Mr. Carlin, will introduce Owen D. Young, chairman of the board of the General Electric Company, who will speak in San Francisco on the subject of "Electricity as a World Power." The entire program will be concluded by Mr. Edison in West Orange.

Soft Governor Pin Causes Flywheel Failure

A worn governor pin was responsible for a flywheel explosion at the General Hospital, Elizabeth, N. J., on May 23, that did damage to the plant and adjacent buildings, but caused no loss of life or personal injury.

The engine was equipped with a flywheel governor and was direct connected to a 125-kw. direct-current generator operated normally at 250 r.p.m., on a steam pressure of 150 lb. The flywheel was of standard two-piece construction bolted at the hub and the rim. All of the spokes, six in number, broke off close to the hub, leaving the hub intact on the shaft. Comparatively little damage was done to the other parts of the unit.

Two sections of the wheel flew in opposite directions, one crashed through the switchboard, one through two brick walls, coming to rest at the street curb. Another section struck a second unit, breaking the frame between the crankshaft and cylinder and temporarily putting it out of commission.

As stated, the initial cause of the accident was wear of the governor pin. This pin appears to have been a replacement made when the engine was overhauled seven months ago. It was of untreated cold-rolled steel, in contrast with the case-hardened and ground carbon-steel pin furnished by the builder of the engine. The pin had worn halfway through and in breaking evidently jammed the governor parts and thus caused the wreck.

Benson Generator Adopted by Hamburg Line

A contract has just been closed by the Benson Super Power Corporation for the installation of the Benson steam generator in certain types of ships owned and operated by the Hamburg-American line. This application of the Benson principle of steam generation without boiling, which was fully described in the May 22 and 29, 1923 issues of *Power*, marks a new departure in marine power design.

Besides the saving in space arising from the compactness of the Benson generator, it is estimated that the economy resulting from the installation of this system on a steamship of the Hamburg-American type will be $103,000 a year. Siemens-Schuckert of Berlin recently constructed an entirely new type of Benson steam generator, primarily intended for use on board ships, which showed an efficiency of 80.2 per cent.

Power System Unification Progresses in Scotland

Inauguration recently of important extensions to the Portobello power station of the Corporation of Edinburgh, Scotland, represents the first step in the unification scheme of the Central Electricity Board, so far as Central Scotland is concerned. The complete project provides for erection of 250 miles of 132,000-volt transmission lines designed for interlinking the power stations of Edinburgh and Dundee, the Fife Power Company, the Corporation of Kirkcaldy, the Scottish Central Electric Power Company, the water power stations of the Lanarkshire Hydro-Electric Power Company, the Dalmarnock and Port Dundas power stations of the Corporation of Glasgow, the three steam power stations at Motherwell, Clyde's Mill and Yoker of the Clyde Valley Power Company, the Delingburn station of the Corporation of Greenock, and the stations of the Corporation of Paisley, and —at Kilmarnock—of the Ayrshire Electricity Board.

This enumeration gives some idea of the vast extent of the work being done but does not indicate all that is in the plans of the board. The Grampian power scheme will ultimately be made part of the system, a connection being made by lines run from Dundee to Abernethy, while line will also run past Loch Doon and through Dumfriesshire to Carlisle, and link up there with similar projects in England. The main idea of the work being done in Scotland is unification of control of all Scottish stations, and ultimate elimination of older and less efficient plants. The full benefits will not be obtained until standardization of frequency is accomplished, but by special acceleration of the changeover program it is hoped that the whole of Scotland will be operating on the uniform periodicity of 50 cycles by the spring of 1932.

Board Approves Bond Vote for San Francisco System

At a meeting held May 26 the San Francisco Board of Supervisors by a vote of 15 to 3 approved the recommendation of the joint finance and public utilities committee that voters of San Francisco be asked to approve at a primary election to be held Aug. 26 the issuance of bonds totaling $68,115,000 to purchase the local distributing systems of the Pacific Gas & Electric Company, and the Great Western Power Company, to make necessary immediate improvements and to construct a new power plant. Four bond issues will be placed upon the ballot as follows: For purchase of P. G. & E. system, $44,600,000; for purchase of Great Western Power system, $18,945,000; for necessary expenditures (five items), $3,525,000; and for Red Mountain Bar power plant, $1,045,000.

The necessary expenditures as determined by the joint committee include $1,190,000 for transmission line, Newark to San Francisco; $730,000 for necessary changes in step-down stations; $670,000 for interconnecting lines; $900,000 for construction of new downtown substation; and $35,000 for cutting over the Pheland Building station load.

News of Canada

Boiler inspectors hold successful conference at Calgary —Revisions made in interprovincial regulations

THE TRIENNIAL CONFERENCE of Provincial Boiler Inspectors of Canada was held in Calgary, Alberta, May 5 to 12, to consider revisions, additions, and changes to the Canadian interprovincial boiler regulations. Alberta served as host to the conference for this meeting, Walter Smitten, Commissioner of Labor of the Province, and F. W. Hobson, Chief Boiler Inspector, officiating. The meetings of the conference were held in the old provincial court house, which was the first masonry structure in Alberta.

Those in attendance at the conference were: D. M. Medcalf, chairman, Ontario; T. Inglis, secretary, Saskatchewan; A. S. Bennett, British Columbia; F. W. Hobson, Alberta; R. A. Stewart, Manitoba; N. S. Walsh, Quebec; and C. W. Obert, representing the A.S.M.E. Boiler Code Committee.

The power boiler, heating boiler, and unfired pressure vessel sections of the Canadian regulations were reviewed, paragraph by paragraph, with a view to correcting and bringing up to date whatever features past experience had shown needed revision. Among the subjects discussed were: bracing and staying of flat surfaces, dished-head construction, furnace construction, factors of safety, and fittings and attachments, including safety valve

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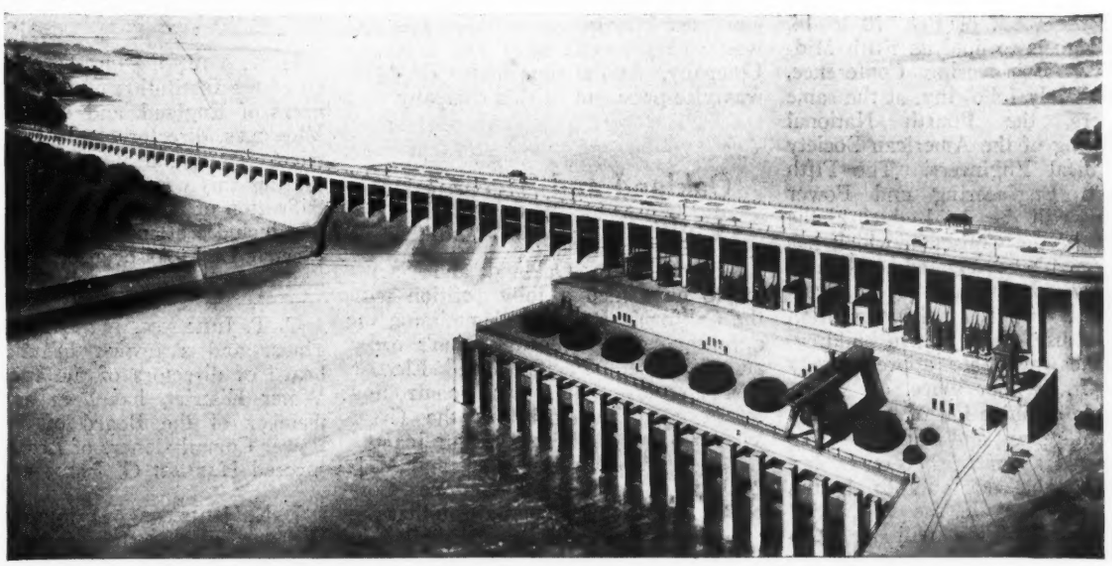
ARCHITECT'S SKETCH OF OSAGE RIVER PROJECT



Completion of this plant at a cost of more than $30,000,000 will increase the capacity of the Union Electric Light & Power Company's system to well over 730,000 kw. The lake formed by the dam will have a shore line of 1,500 miles

requirements. One of the most important features of the conference was the discussion on fittings and attachments, in which there had been a lack of uniformity of practice. As a result, many of the features of the rules in which the different provinces were at variance were satisfactorily adjusted.

DUE CONSIDERATION was paid to low-pressure heating boilers and to unfired pressure vessels, and here also efforts were made to place the rules on a basis where the various provincial inspectors could agree on uniformity of enforcement. Particularly in connection with applications of welding were such studies of importance and value, in view of the greatly increased use of welded construction. The members of the conference agreed that the use of welded construction is advancing at a rate that commands their serious attention and thought. For this reason the developments in both Europe and the United States were carefully studied. Recent revisions in the A.S.M.E. unfired pressure vessel code and also the proposed A.S.M.E. specifications for welded boiler drums were considered, and a number of important modifications of these two sections of the interprovincial boiler regulations were agreed upon.

At the close of the conference adjournment was taken for a period of two years. It was the hope of the members that the conference could be established on a biennial basis in the future, or perhaps on an annual basis. The next meeting was scheduled to be held at Montreal in the Spring of 1932. D. M. Medcalf was re-elected chairman of the conference, and T. Inglis, secretary.

Chicago to Hold Power Show, Fuels Meeting in 1931

During the week of Feb. 10 to 14, 1931, Chicago is to hold its Fifth Midwest Power Engineering Conference, and, immediately following, at the same headquarters, the Fourth National Fuels Meeting of the American Society of Mechanical Engineers. The Fifth Midwestern Engineering and Power Exposition will be held during the same week at the Coliseum, which has been thoroughly renovated and now offers every convenience for mechanical displays. Plans for the exposition call for the use of the entire building, which makes available approximately 100,000 sq.ft. of floor space.

The triple combination of exposition, power conference and fuel meeting offers unusual advantages to engineers, who will be able not only to discuss the latest practices in the two allied fields, but in addition will have an opportunity to inspect new equipment in the field. Preparations for the meetings are already under way. The program will be announced when more fully developed.

P. Albert Poppenhusen Dies; Was Stoker Manufacturer

At his home in Chicago on May 27, P. Albert Poppenhusen, at one time president of the Green Engineering Company, died at the age of 56 after a lingering illness of several months.

P. Albert Poppenhusen

With his brother Herman, in 1897, Mr. Poppenhusen organized the Green Engineering Company, which at the beginning acted as western representative for four large accounts involving the sales of boilers, economizers, heaters, and high-speed engines. As early as 1893, however, he had definitely become interested in stoker manufacture.

Mr. Poppenhusen served as secretary and treasurer of the company until 1901, when he became president, and continued as the chief executive until his company was absorbed by the Combustion Engineering Corporation in 1922. After remaining with the new combination for a short time to help effect the consolidation, he became associated with R. C. and E. A. Acers, forming in 1925 the firm of Acers Poppenhusen Company, which acts as western representative of The Engineer Company. At the time of his death he was vice-president of this company.

Oakland and Sacramento Fight P. G. & E. Merger

The cities of Oakland and Sacramento have filed a joint petition with the California Railroad Commission for a rehearing of the commission's order authorizing the Pacific Gas & Electric Company to acquire the controlling interest in the stocks of the Great Western Power Company, San Joaquin Light & Power Corporation, and Midland Counties Public Service Corporation. The petitioners allege that the commission exceeded its jurisdiction in authorizing, in effect, the transfer of the franchises granted by the city of Oakland to the Great Western Power Company, without requiring the company to obtain the consent of the city.

Personals

JOSEPH G. WORKER, assistant to the president of the American Engineering Company, was elected president of the Stoker Manufacturers' Association at its recent annual meeting. Other officers elected are: Vice-president, WILLIAM F. TURNER of the Flynn & Emrich Company; secretary, WILLIAM V. MCALLISTER of the Riley Stoker Company; and treasurer, F. H. DANIELS also of the Riley company. At the meeting two new member companies were admitted, Combustioneer, Inc., Goshen, Ind., and the Auburn Stoker Company, Auburn, Ind.

HARLOW D. SAVAGE, former president of the Combustion Engineering Corporation and widely known in engineering circles, has been appointed head of the League of New York Theaters, Inc., an organization of play producers, theater managers and ticket brokers formed by curb ticket speculators in New York.

HARRY W. FULLER, vice-president in charge of engineering and construction of the Byllesby Engineering & Management Corporation, has been elected chairman of the Fifth Midwest Power Engineering Conference to be held in Chicago the week of Feb. 10, 1931.

E. F. PEARSON, formerly electrical engineer of the Northwestern Electric Company, has been appointed chief engineer of the company. TOM PERRY, who was superintendent of the plant department, is now assistant general superintendent of the company.

FRANK H. PROUTY, a member of the firm of Prouty Bros. Engineering Company, was recently elected president of the Colorado Section of the American Society of Mechanical Engineers. ARTHUR HALLIWELL, assistant superintendent of the General Iron Works Company, was elected secretary-treasurer of the section.

H. T. YOUNG, a member of the council of the Institution of Electrical Engineers of England, and Lt. Col. W. A. VIGNOLES, director of the British Electrical Development Association, are touring this country to study the electrification of American industry. Their trip includes attendance at the National Electric Light Association convention in San Francisco next week.

O. T. JOHNSON, JR., Los Angeles engineer and a former member of the board of directors of the Metropolitan Water District, has been appointed a member of the Board of Water and Power Commissioners of Los Angeles to succeed HARLAN G. PALMER.

J. N. JUNKINS has joined Stone & Webster Engineering Corporation as engineer in the industrial division. For the past year and a half he has been associated with the Atlas Tack Corporation as plant engineer on plant improvements.

Business Notes

DAMPNEY COMPANY OF AMERICA, Boston, Mass., announces the appointment of R. G. Ingram to supervise its sales agencies in the Middle West. Mr. Ingram will maintain his headquarters at One La Salle St., Chicago, Ill.

BOILER ENGINEERING COMPANY, Newark, N. J., is now being represented in the Metropolitan district by Warren C. Drake with offices at 5 Beekman St., New York, N. Y.

OHIO STEEL FOUNDRY COMPANY, Lima and Springfield, Ohio, has purchased the steel foundry department and steel casting business of the Industrial Brownhoist Corporation, Cleveland, Ohio, and Bay City, Michigan.

JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has elected J. Frank Davidson to the position of vice-president and assistant general manager. Mr. Davidson has been associated with this company since 1911 and served as purchasing agent before being appointed assistant general manager.

TERRY STEAM TURBINE COMPANY, Hartford, Conn., has appointed S. O. Maxwell district manager of the New York office at 90 West Street. For the past few years Mr. Maxwell has acted as assistant New York manager.

AMERICAN PUMP & SUPPLY COMPANY, Detroit, Mich., headed by F. W. DuBois, has merged its business with the sales organization formerly known as Tomlinson-MacLachlan, Inc., handling power plant equipment and steam and water specialties. Simultaneously with the consolidation, A. H. Chas. Dalley, for the past thirteen years western manager of the Superheater Company, with headquarters in Chicago, became an active associate in the new organization to be known as Dalley & DuBois, Inc., with offices and warehouse at 464 West Jefferson Avenue.

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Trade Catalogs

INSTRUMENTS — Graphic instruments for alternating and direct current; switchboard, wall and portable types, are described in Bulletin No. 830 of the Roller-Smith Company, 233 Broadway, New York, N. Y.

WELDING—"Arc Welding in Industry" is the title of a new bulletin printed by the General Electric Company, Schenectady, N. Y. This covers the use of arc welding in structural steel, tanks and pressure vessels.

PUMPS—Catalog No. 102 describing the Evactor steam jet air pump has just been published by the Croll-Reynolds Company, Inc., 17 John St., New York, N. Y.

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COMING CONVENTIONS

American Institute of Electrical Engineers. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

National Association of Power Engineers. Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Chattanooga, Tenn., June 17-19. Secretary, C. O. Myers, 14 Commercial National Bank Bldg., Columbus, Ohio.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

Universal Craftsmen Council of Engineers. Annual convention at the Hotel Kimball, Springfield, Mass., Aug. 5-8. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

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ALLOY STEELS—Reprints of a paper delivered before the Railroad Division of the A.S.M.E., at its annual meeting, New York City, December, 1929, by Charles McKnight, in charge of alloy steel development, International Nickel Company, 67 Wall St., New York, N. Y., discuss the increase in strength with decrease of weight attainable by the use of alloy steel for railroad forgings, castings, and boiler plate, and the comparative physical properties of alloy and carbon steels in such applications.

FURNACE SPECIALTIES—The Quigley Furnace Specialties Company, Inc., 56 West 45th St., New York, N. Y., has just printed a bulletin entitled "Hytempite in the Power Plant," which features the uses of this product for boiler settings, baffles, special shapes, repairs, etc. The method of making inclined or vertical monolithic baffles with crushed firebrick and Hytempite is described.

TERMINATORS—A bulletin, 65-B, describing a new terminator for sealing ends of low- and high-voltage, lead-covered cables, is being distributed by the Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill. This bulletin pictures a number of wet and dry flashover tests made in the Delta-Star laboratory.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Navy Standard	New York	$2.10 @ $2.30
Kanawha	Columbus	1.35 @ 1.60
Smokeless	Cincinnati	1.90 @ 2.00
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.35 @ 1.60
Steam	Pittsburgh	1.50 @ 1.60
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.50 @ 1.75
Anthracite (Gross Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.00
Barley	New York	1.25 @ 1.50

FUEL OIL

New York—June 5, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

St. Louis—May 29, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.470 per bbl., or 42 gal.; 26@28 deg., $1.545 per bbl.; 28@30 deg., $1.620 per bbl.; 30@32 deg. $1.695 per bbl.; 32@36 deg., gas oil, 4.151c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—June 3, f.o.b. local refinery, 30@34 deg., fuel oil, 3.75c. per gal.; 36@40 deg., 4c.

Philadelphia — May 31, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — June 3, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—May 31, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 75@80c. per bbl.; 26@30 deg., 85@90c. per bbl.; 30@32 deg., $1.00@$1.05 per bbl.

Boston—June 3, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—May 31, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Oakland—C. H. Lee and R. W. Meyers, have filed application for a power development on the Illinois River near Roseburg to include dam, reservoir and tunnel.

Calif., San Francisco — Bell Bros., Mills Bldg., awarded contract for the construction of a 2 story refrigeration plant at 12th and Bernice Sts., to Cahill Bros., 206 Sansome St. Estimated cost $40,000.

Ga., Columbus—City, H. B. Crawford, Mgr., will soon receive bids for addition to hospital, nurses home and boiler house, including new boiler equipment. Estimated cost $150,000. E. C. Wachendorff, 1010 Standard Bldg., Atlanta, is architect. T. F. Lockwood, Murrah Bldg., Columbus, is associate architect.

Ill., Springfield—City received lowest bid for extensions and improvements to power house from Alzuir Construction Co. $64,960. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, Mo., is engineer.

Ill., Winnetka—City is having preliminary plans prepared for addition to municipal power plant and waterworks station on Lake at Tower Rd. Estimated cost $350,000. Bylesby Engineering & Management Corp., 231 South La Salle St., Chicago, is engineer.

Mass., Brookline—Edison Electric Illuminating Co., 39 Boylston St., Boston, plans the construction of a power substation at Beaconsfield and Bear Den Rd. Estimated cost $50,000. Architect not selected.

Mass., Gloucester—City is having plans prepared for the construction of a waterworks system, including dam, reservoir, pumping station, etc. Estimated cost $250,000. Fay, Spofford & Thorndike, 44 School St., Boston, are engineers.

Mich., Flint—D. A. Bohlen & Son, 1001 Majestic Bldg., Indianapolis, Ind., Archts., will receive bids until June 30 for a 4 story hospital, including steam heating, ventilation and refrigeration systems, boilers, elevators, etc., on East Kearsley St. for St. Josephs Hospital Association, 720 Ann Arbor St. Estimated cost $1,250,000.

Mich., Grosse Pointe Farms — City, J. R. Kirby, Chn., will receive bids until June 26 for the construction of a waterworks system, including filtration plant and pumping station, etc. Hoad, Decker, Shoecraft & Drury, Ann Arbor.

Mo., Campbell—City awarded contract for the construction of a municipal power plant to W. D. Beasley and A. McBridge, Campbell, also distribution system to Willoughby Construction Co. of North Carolina, and equipment to Fairbanks-Morse Co., 217 South 8th St., St. Louis, Mo., $60,000.

N. H., Pittsburgh—Connecitcut Lakes Conservation, c/o New England Power Construction Co., 89 Broad St., Boston, will build a dam here. H. T. Pierce, c/o owner, is engineer. Work will be done by owner's forces.

N. J., Asbury Park—M. Erskine, 1716 Chestnut St., Philadelphia, Pa., Archt., is receiving bids for the construction of a 5 story hospital, nurses home and boiler house on Corlies Ave., for Memorial Hospital, c/o architect. Formerly reported under Allenhurst.

N. J., Burlington—Public Service Electric & Gas Co., 80 Park Pl., Newark, is having surveys made by United Engineers & Constructors, 112 North Broad St., Philadelphia, Pa., for a steam power plant here. Initial installation two 60,000 kw. turbo generators. Total estimated cost $50,000,000. Cotnract will be awarded wihout competition to the engineers.

N. J., Hackettstown—F. W. Wentworth, 140 Market St., Paterson, Archt., will receive bids about June 15 for a 1 story, 30 x 60 ft. boiler house on Church St., for Centenary Collegiate Institute, Church St. Estimated cost $40,000.

N. J., Northfield—Bd. of Chosen Freeholders, Guarantee Trust Bldg., Atlantic City, will receive bids until June 11 for the construction of a boiler house, including high pressure steam boilers and settings, etc., here. Estimated cost $40,000. S. H. Vaughn, Guarantee Trust Bldg., is engineer.

N. D., Williston—Great Northern Railway Co., Railroad Bldg., St. Paul, plans the construction of a power plant here. Estimated cost $40,000. T. D. McMahon, 1225 Railroad Bldg., St. Paul, is engineer.

O., Cleveland—City, D. E. Morgan, City Mgr., received lowest bid for a 1 story, 67 x 74 and 23 x 23 ft. additions to boiler house at Warrensville Farm from W. J. Schirmer, 1720 Euclid Ave. Estimated cost $100,000.

Pa., Pittsburgh—City Ice & Fuel Co., 6611 Euclid Ave., Cleveland, O., awarded general contract for the construction of a 7 story cold storage plant at Penn and Pike Sts., here, to Blome Sinek Co., 33 South Clark St., Chicago, Ill. Estimated cost $2,500,000.

Tenn., Loudon — City awarded contract for complete water system to Kelly & Wilson, Asheville, N. C., $60,000; also bids June 24 for power house, etc. J. B. McCrary Engineering Co., Citizens & Savings Bank Bldg., Atlanta, Ga., is engineer.

Tenn., Memphis—Memphis Power & Light Co., 179 Madison Ave., has work under way on extensions and improvements at Central Station. Estimated cost $333,000. Work by owner's forces.

Tex., Abernathy—Texas Utilities Co., Plainview, awarded contract for a 1 story, 120 x 156 ft. power plant here, to Harrison & Smythe, Plainview. Estimated cost including equipment, $150,000.

Tex., Dallas—Dallas Power & Light Co., c/o C. N. Davis, V. Pres. and Gen. Mgr., has been granted permit to construct a power plant and reservoir at Mountain Creek near Grand Prairie. Estimated total cost $7,000,000.

Tex., Mobeetie—Panhandle Light & Power Co., Borger, plans the construction of a power and light plant, including 6,500 kw. steam pressure unit to supply current to 66 kv. transmission line out of Borger. Estimated cost $3,000,000. United Light & Power, Engineering & Construction Co., 1330 Grand Ave., Kansas City, Mo., is engineer. A. B. Taylor, Borger, is consulting engineer.

Tex., San Antonio—T. E. Whithead, Constructing Quartermaster, will receive bids until June 20 for furnishing and installing twelve heating systems, including gas fired boilers in Infirmary and Barracks buildings at Artillery post, Fort Sam Houston. Estimated cost 90,000.

Wash., Kennydale—Kennydale Water Co., F. J. Friedel, Secy., will soon award contract for waterworks and distribution systems, including pumping plant, automatic motor driven pumping unit, etc. Estimated cost $40,000. Miller Engineering Co., Burke Bldg., Seattle, is engineer.

Wis., Columbus—City is having plans prepared for extensions and improvements to light plant. Burns & McDonnell Engineering Co., 400 Interstate Bldg., Kansas City, is engineer.

B. C., Nelson—City will receive bids until June 28 for extensions and improvements to municipal electric light and power system. Estimated cost $75,000. W. D. Fleet, City Hall, is engineer.

B. C., Vancouver — St. Pauls Hospital, is having plans prepared for a 5 story nurses home including power house on Barrard St. Estimated cost $250,000. Gradiner & Mercer, Birks Bldg., are architects.

Ont., Peterborough—Silverwood's Ltd., H. O. 133 King St., London, awarded contract for the construction of a 15 ton ice plant to Cuff Bros., 30 McGill St. Estimated cost $50,000. Equipment contract let.

Equipment Wanted

Engine—Pawhuska, Okla.—City plans the installation of a 600 hp. Diesel oil engine in power plant. Estimated cost $60,000.

Light Plant Equipment—Pasadena, Calif.—City, B. Chamberlain, Clk., will receive bids until June 19 for electric light plant equipment including two 15,000 sq.ft. boilers, air preheaters, automatic superheaters, etc.

Power Equipment—Winnsboro, S. C.—U. S. Rubber Co., Winnsboro and 58th St. and Broadway, New York, N. Y., plans an extensive purchase of electric power equipment. $150,000.

Pump—Moline, Kan.—City, J. W. Turner, Clk., will receive bids until June 16 for a 300 g.p.m. pump and complete filter equipment for proposed waterworks improvements.

Pump—Simcoe, Ont.—Town Council, plans to purchase a vertical electrically driven pump for proposed waterworks improvements. Estimated cost $15,000.

Pumping Equipment — Vancouver, B. C. — City, W. A. Sheppard, Purch. Agt., City Hall, will receive bids until June 23 for pumping equipment and accessories for proposed airport. Estimated cost $300,000.

Pumps—Randolph, Ia.—City, M. Fichter, Clk., will receive bids until June 17 for 75 g.p.m. deep well single stroke pump, 75 g.p.m. deep well double stroke pump and 75 g.p.m. vertical deep well turbine pump, etc., for proposed waterworks system.

Pumps — Pittsburgh, Pa. — Duquesne Light Co., 435 6th Ave., C. W. Lepper, Purch. Agt., will receive bids until June 18 for six motor driven centrifugal pumps and appurtenances at Brilliant pumping station.

Pump — Scarsborough, Ont. — Scarsborough Public Utilities Commission, additional gasoline driven and electrically driven centrifugal pumps, etc., for proposed waterworks extensions. Estimated cost $50,000.

Pumps, etc. — Toronto, Ont. — City, B. S. Wemp, Mayor, City Hall, will receive bids until July 29 for two 24 m.g.p.d. and two 10 m.g.p.d. centrifugal pumps with induction motors and control equipment for High Level pumping station. $50,000.

Industrial Projects

Calif., Los Angeles—Wilhite Machine Works, 165 North La Brea Ave., manufacturers of lighting fixtures, plans the construction of a 2 story factory at 28th and Main Sts. Estimated cost $40,000.

Conn., Hartford — Hartford Special Machine Co., Homestead Ave., is having plans prepared for a 2 story factory at Homestead Ave. Estimated cost $50,000. Greenwood & Noerr, 525 Main St., are architects.

Ill., Chicago—Nimmons Carr & Wright, 333 North Michigan Ave., Archts., are receiving bids for the construction of a confectionery manufacturing plant and power plant for Crackerjack Co., 530 South Peoria St. Estimated csot $750,000.

Ill., East St. Louis—Wailes Dove-Hermiston Corp., 17 Battery Pl., New York, awarded contract for a 1 story, 50 x 260 ft. paint and enamel plant and 30 x 80 ft. office at 29th and Illinois Ave., to W. H. and N. Cunliff Co., 3327 Lindell Blvd., St. Louis, Mo. Estimated cost $100,000.

Ind., Fort Wayne — International Harvester Co., 606 South Michigan Ave., Chicago, Ill., is having plans prepared for addition to factory on Bueter Rd., here. Estimated cost $50,000. Private plans.

Ind., Marion—U. S. Radio Co., awarded contract for a 100 x 300 ft. factory on South Adams St. to Bowman Construction Co. Estimated cost $46,000.

Mass., Springfield — Chapman Valve Co., Indian Orchard, awarded contract for a 1 story, 90 x 125 and 75 x 210 ft. valve manufacturing and foundry units to Adams & Ruxton Construction Co., 1387 Main St. Estimated cost $50,000.

N. J., Harrison—Driver-Harris Co., Middlesex St., will receive bids about July 1 for a 1 and 2 story addition to factory on Middlesex St. Estimated cost $250,000. J. A. Finegan, 776 Broad St., Newark, is architect.

N. J., Jersey City—B. Singer, 921 Bergen Ave., Archt., will receive bids about June 15, for a 2 story, 45 x 140 ft. factory on Crawford St., for Jersey City Ladder Co., Inc., 677 Montgomery St. Estimated cost $40,000.

N. J., North Bergen—Wilson Welder & Metal Co. Inc., Terminal Bldg., Hoboken, awarded contract for a 1 story, 145 x 205 ft. factory at 38th St. and Bergen Turnpike to Bonnanno Bros. Inc., 1827 Bergen Turnpike. Estimated cost $40,000.

N. J., Perth Amboy — General Cable Corp., 420 Lexington Ave., New York, is receiving bids for two 1 and 2 story, 56 x 85 and 90 x 100 ft. factory buildings at DeKalb Ave. and High St. Estimated cost $40,000. Private plans.

N. Y., Syracuse—Pierce, Butler & Pierce Mfg. Co., 41 East 42nd St., New York, plans to rebuild boiler and radiator manufacturing plant at Pearl and Canal Sts., here. Estimated cost to exceed $200,000.

O., Canton—Prest-O-Lite Co., Inc., 30 East 42nd St., New York, N. Y., plans the construction of a 1 story acetylene producing plant on 17th St. N. E. Estimated cost $50,000. Private plans.

O., Canton — Timken Roller Bearing Co., Dueber Ave. S. W., plans the construction of a 1 story, 120 x 154 ft. bearing hardening plant on Harrison Ave. S. W. Estimated cost $50,000. Private plans.

O., Cleveland—Fisher Body Co., General Motors Bldg., Detroit, Mich., awarded contract for a 1 story, 83 x 400 and 1 story, 30 x 100 ft. die stamping building and shipping dock at East 141st St. and Cort Rd. to J. A. Utley, 700 Harper Ave., Detroit. Estimated cost $300,000.

O., Cleveland—Lamson & Sessions Co., F. C. Case, Chn. of Board, 1971 West 85th St., manufacturers of bolts and nuts, awarded contract for a 1 story, 110 x 120 ft. addition to factory, to A. M. Highley Co., Plymouth Bldg. Estimated cost $75,000.

O., Cleveland—Westinghouse Electric & Mfg. Co., W. H. Frenier, Supt. of Construction, West 54th St., will soon award contract for a 1 story, 60 x 80 ft. galvanizing plant. Estimated cost $40,000. Private plans.

O., Springfield—Cities Service Co., awarded contract for the construction of a 1 story compounding plant, to A. G. Samuelson. Estimated cost $80,000.

Wis., Sheboygan—Gorton Toy Co., awarded contract for the construction of a 4 story, 109 x 218 ft. factory to Martin DeNy, Sheboygen.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

THE downward trend is still evident in prices of power-plant and electrical supplies, in keeping with the movement of commodities prices in general. Declines of May affected mainly black and galvanized conduit, rubber-covered copper wire, cement, linseed oil, rivets, babbitt metal and cold-finished shafting or screw stock. Steel rivets, ½-in., round-head, are down 20c. per 100 lb., to $2.90, Pittsburgh. Cold-finished shafting declined 25c. per 100 lb., to $3.35 for round or hexagonal, at Chicago warehouses. The drop in conduit, which occurred at New York warehouses, amounts to a reduction of about 2.7 per cent from May 13 levels.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50%

Air—Best grade

¾-in., per ft.	3-ply	$0.30	4 ply	$0.36

Steam—Discounts from List

First grade	40%	Second grade	45%	Third grade	50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting in quantities of about ½ doz. rolls:

Best grade	50%	Second grade	60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30-5%; 2nd grade, 45-5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30-5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.15@$2.20 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	13½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.146	$0.164	$0.15

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	14.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, 7/8-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	2.90

*This price is for full kegs; broken-kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	51.00
Commercial genuine, intermediate grade	37.00
Anti-friction metal, general service	31.00
No. 4 babbitt, f. o. b.	11.00

COLD-FINISHED STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.35
Flat or square	3.90	4.15	3.85

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..	$0.05 per cut	3-in.....	$0.09 per cut
2¼ and 2½ in.....	.06 per cut	3½ to 4 in..	.10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$27.00	$42.00	$115.00	$143.00
No. 12 solid....	41.00	41.75	117.00	166.00
No. 10 solid....	57.00	72.00	137.00	189.00
No. 8 stranded..	91.00	115.00	220.00	295.00
No. 6 stranded..	135.00	163.00	295.00	.....

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. New York warehouse shipment. Discount of 5 per cent for payment in 10 days; 30 days net.

Size,	GALVANIZED			BLACK		
Inches	Conduit	Elbows	Couplings	Conduit	Elbows	Couplings
¼	$58.30	$8.33	$4.79	$53.27	$7.21	$4.38
⅜	74.34	10.97	6.84	67.55	9.49	6.25
1	106.55	16.24	8.90	96.50	14.04	8.14
1¼	144.16	21.97	12.48	130.57	19.31	11.47
1½	172.37	29.31	15.41	156.11	25.76	14.17
2	231.91	54.71	20.55	210.04	47.20	18.90
2½	366.67	87.91	29.36	332.10	77.27	27.01
3	479.50	234.10	44.04	434.29	205.74	40.50
3½	603.84	516.92	58.74	549.47	454.09	54.02
4	736.89	597.18	73.41	672.47	524.78	67.50
4½	858.58	904.12	110.00	783.52	794.50	101.23
5	1000.55	1255.26	121.13	913.08	1103.08	111.37
6	1298.01	1560.33	176.12	1184.54	1371.20	161.93

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$19.00
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		14.00
No. 16 cotton reinforced light		18.50
No. 18 cotton Canvasite cord		15.00
No. 16 cotton Canvasite cord		18.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$68.00	*74.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	102.00	*112.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
REFILLS—				
1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.80
0–30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt— Watts	General Type	Price Each	200—260 Volt— Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.60	$7.30	$7.85	$14.35
12	7.70	9.25	10.22	18.30
10	10.31	12.20	13.40	24.25
8	15.10	17.75	19.40	35.00
6	.....	.....	26.80	.....
4	.....	.....	39.40	.....
2	.....	.....	56.00	.....
1	.....	.....	92.00	.....
0	.....	.....	99.00	.....
00	.....	.....	119.00	.....
000	.....	.....	144.00	.....
0000	.....	.....	175.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap— Key	Keyless	Pull	¾ In. Cap— Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb.
Wire solder, in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%